Mining Journal

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Roosevelt Drainage Tunnel, Cripple Creek, Colorado

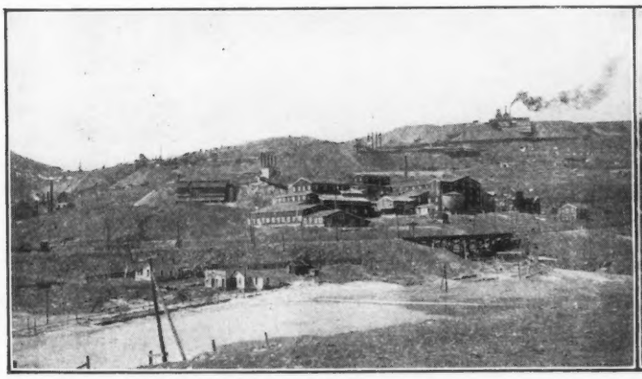
By T. H. Sheldon*

SYNOPSIS—The present tunnel, about 3 mi. long, will be extended about 2 mi. farther and is expected to drain Vindicator, Golden Cycle and other mines beyond a nearly vertical syenite dike, which being impervious, prevents these mines benefiting from drainage now afforded mines on the other side of the dike. Estimated cost $200,000; time to complete, 2 yr. The work, which will be undertaken immediately, is in strong hands.

On July 26 and 27 a meeting of the board of directors of the Cripple Creek Deep-Drainage and Tunnel Co. was held in Colorado Springs for the purpose of filling vacancies in the board caused by the death of Frank F. Castello, of the Mary McKinney company, and the resignation of Allen Burris, of the El Paso; also for formulating plans to insure the continuance of the Roosevelt drainage tunnel to the eastern end of the district. The vacancies were filled by the election of Adolph J. Zang, of the Vindicator company, and Richard Roelofs, of the Cresson.

The executive committee, in charge of the work, was increased from three to five members by the addition of Irving T. Snyder, secretary of the Golden Cycle Mining and Reduction Co., and Mr. Roelofs. The other members of this committee are James F. Burns, of the Elkton company, chairman; Irving Howbert, of the Portland, and John Tait Milliken, of the Cycle company. Mr. Snyder is also general manager of the Vindicator company; therefore the addition of these two new members to the executive committee should remove any doubts as to the completion of the tunnel past the Cresson to the Vindicator and Golden Cycle mines, which will benefit also the Portland, Independence and Strong mines.

The board of directors passed a resolution commending the work of Mr. Burns, chairman of the committee, in pushing the tunnel through during the past year in the face of unusual difficulties. A good deal of loose ground was encountered, making the progress slow and requiring a great amount of expensive timbering. The work was suspended for about five months while the El Paso surface plant, destroyed by fire on Nov. 4, was being rebuilt, all the work of excavation being carried on through that shaft.



BATTLE MOUNTAIN, CRIPPLE CREEK DISTRICT

The view includes the Strong, Ajax, Independence and Portland mines and Portland mill

CAMP AT SITE OF THE ROOSEVELT TUNNEL

The entrance to the tunnel is at 8,033 ft. elevation. Present flow from tunnel, 11,000 gal. per min.

On Aug. 16 Mr. Howbert resigned from the board, his place being filled by Mr. Peck, president of the Portland company. A. E. Carlton was elected chairman of the board, and he appointed Mr. Snyder chairman of the executive committee, to take the place of Mr. Burns, who tendered his resignation at that time.

With this reorganization of the executives the work of the tunnel extension is expected to be pushed vigorously and without interruption.

The expense of driving the original Roosevelt tunnel was defrayed by the various larger companies of the district. For the extension, which has been financed in the same manner, $200,000 has been pledged, the

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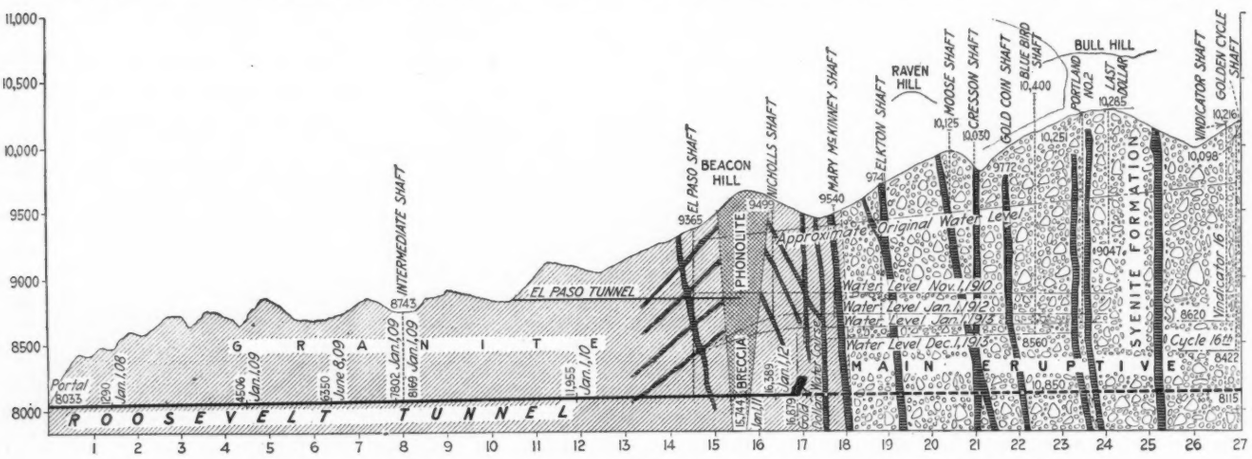
heaviest contributors to this fund being the Portland, the Vindicator and the Cresson—the mines most vitally interested in this work. The distance yet to be driven is a little over 10,000 ft.—about 2 mi.; but as the formation is all breccia and spongy eruptives which can be easily drilled and broken, it is expected that progress will be more rapid and the expense correspondingly less than when the tunnel was being bored through solid granite. The cost of this new work is estimated at $20 a foot.

The tunnel extension will pass largely through ground owned by the contributing companies. Right-of-way will be granted by lease, and any veins or orebodies that may be encountered will be worked under these leases.

Even at the risk of repeating what may already be known to some *Journal* readers, a brief sketch of the work of draining the Cripple Creek district may not be out of place at this time. In the earlier days of the camp the water question was not a serious one; but as the more important shafts increased in depth the seepage began to be very troublesome, and below 500 ft. from the surface, operations were greatly hampered by the flow of water. The original water level was about 9,500 ft. above sea level on the western side of the district and 9,700 ft. on the eastern side, the drainage roughly following the contour of the country in its slope from the top of Pike's Peak southwest to the valley of the Arkansas River. The first mines to feel discomfort were those in the southwestern corner of the district, being lower in elevation, especially the El Paso and Elkton.



CROSS-SECTION OF CRIPPLE CREEK DISTRICT TAPPED BY ROOSEVELT TUNNEL

At first each mine installed its own pumping plant; but as the depth of the workings increased, the unwatering of the mines became so expensive and the outlay of capital for plants adequate to handle the flow of water so enormous, that the mine operators began to consider ways and means for unwatering the entire district by a central pumping plant, or two or three such plants, supported by all the mines interested. This plan was rejected because the benefits to be derived were not considered commensurate with the expense. Several joint pumping plans were tried, but none was particularly successful.

Among the larger individual pumping plants may be mentioned the one at the Portland mine. The first large pump at this mine was a Snow duplex compound condensing unit, installed in 1897 on the 800-ft. level. The dimensions of the steam cylinders of this pump were 18¼ and 34 in.; the plunger, 9¼ in.; the stroke, 36 in.; and the capacity, 1,000 gal. per minute at that depth. A year or two later a Knowles triple-expansion condensing pump was installed on the 900-ft. level. The size of this pump was 18&28&42x10 in., by 36-in. stroke, and the capacity, 1,200 gal. per minute. In 1908 the Snow pump was moved from the 800-ft. to the 1,500-ft. level of the No. 2 shaft, and the water was pumped from that level to the 900 and sluiced over to the No. 1 shaft, where the Knowles pump delivered it to the surface. Water-tight dams were placed in the adjacent old workings on the 900, making an underground reservoir of 400,000 gal. capacity. By this means the Knowles pump could be run 16 hr. a day, while the Snow pump on the 1,500 was working continuously. The cost of operating this plant was about $3,000 a month, handling 525 gal. per minute. The entire cost of the installation was not less than $50,000.

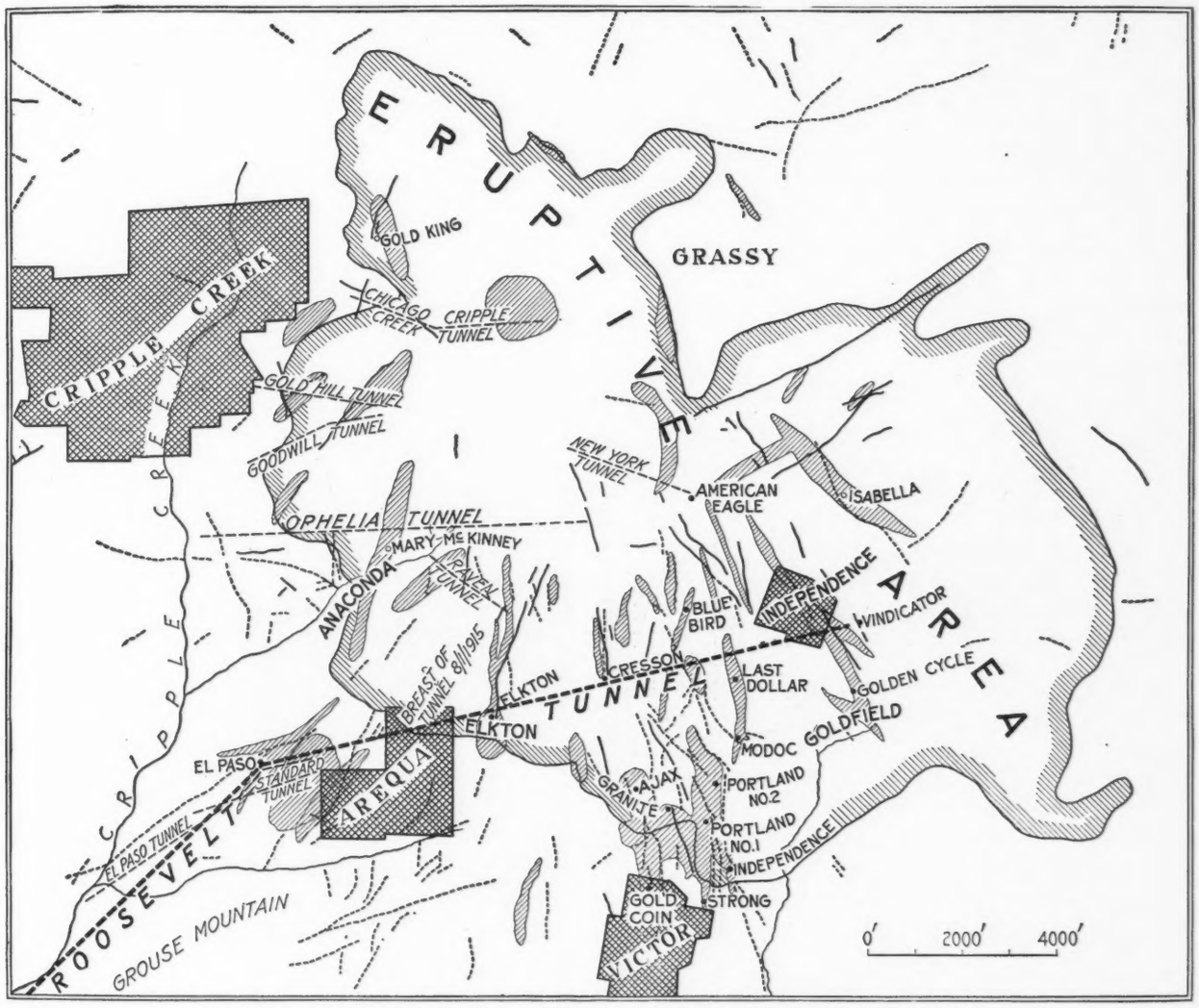
In the meantime the El Paso mine was bending its efforts toward a tunnel to drain its lower workings; and while this was not the first tunnel for drainage only, its success and that of other similar attempts led the mine operators to abandon the plans for pumping and to concentrate on the tunnel project. Financing this undertaking was no mean task and the choice of location no small problem. Every 100 ft. added to the depth of drainage meant 1,000 ft. added to the length of the tunnel to be driven, $30,000 to the capital to be raised, and six months to the time of waiting for the relief from the seemingly constant water level. Finally, however, the money was all pledged and the present Roosevelt tunnel, which is the only concerted effort at the drainage of the entire district to a great depth, was decided upon.

Among the former drainage-tunnel projects may be mentioned the Blue Bell, at 9,350 ft. elevation above sea level; the Ophelia, at 9,300 ft.; the Standard, at 9,050 ft.; the Newell, at 8,941 ft.; and the El Paso, at 8,800 ft. These tunnels, with the exception of the Newell, which does not tap the mineral-bearing area, all produced a heavy discharge of water, which continued until the level was lowered to their respective elevations.

The theory upon which the drainage-tunnel idea is based is that the mineralized area of the Cripple Creek

district is a more or less spongy eruptive formation surrounded by impervious Archean rock, which holds a supply of water like a reservoir; that tapping this crater would drain the entire district; and that this drainage would be permanent because of the relatively light rainfall. This theory was opposed by some engineers, who maintained that the crater is composed of a series of watercourses having no connection with one another, and that tapping one would by no means drain any of the others. This opposition delayed the financing of the Roosevelt tunnel to a considerable degree; and indeed it was not without grounds, for the Vindicator and Golden Cycle mines have not been drained at all, while all the rest of the district has been benefited, until now these two mines are the only ones that find it necessary to pump in order to keep their lower levels dry. But if the theory of separate watercourses were entirely true, the whole district, with the exception of the Vindicator and Cycle, would not be so well drained from one point as it now is; and the lack of drainage in these two mines is thought to be caused by an impervious syenite dike just east of the Last Dollar mine. Piercing this dike is expected to relieve the situation, and is one of the reasons for the extension of the tunnel; more rapid drainage of the mines already benefited being another.

Work on the Roosevelt tunnel was started in June, 1907, at a point in Cripple Creek Cañon about five miles below the city of Cripple Creek and at an elevation of 8,033 ft. above sea level. After several months' effort a contract for the completion of the tunnel was let to A. E. Carlton, president of the First National Bank of Cripple Creek, under whose energetic management the tunnel was driven 14,167 ft. at an average cost of $27.27 per foot. The first eruptive formation was struck Nov. 19, 1910, and with it a flow of water of more than 10,000 gal. per minute. The tunnel, however, was continued to the El Paso shaft, then deflected toward the east until the Gold Dollar watercourse in Arequa gulch was struck in March, 1912, when work was discontinued. About a year ago it was resumed under the direction of Mr. Burns, who drove the tunnel 970 ft. toward the Elkton shaft, the flow of water increasing by about 2,000 gal. per minute as a result of this extension. In the meantime a churn-drill hole was driven from the bottom of the El Paso shaft to the tunnel, quickly and effectively draining this mine. The shaft has since been sunk to the tunnel level. The so-called Fuller crosscut to the north was also driven to intersect the C. K. & N. watercourse. The total length driven is about 17,000 ft., or a little over three miles.



MAP OF CRIPPLE CREEK DISTRICT TAPPED BY ROOSEVELT TUNNEL

The following figures giving the elevations of the water level in the Portland No. 2 shaft show the effect the tunnel has had on the drainage of the eastern end of the district:

	El. Above Sea Level
Nov. 3, 1910	8,858.95
Jan. 1, 1911	8,850.95
Feb. 1	8,843.29
Mar. 1	8,837.29
Apr. 1	8,830.62
May 1	8,824.95
June 1	8,817.62
July 1	8,811.62
Aug. 1	8,806.95
Sept. 1	8,803.45
Nov. 1	8,794.45
Dec. 1	8,787.75
Dec. 23	8,779.95
Shaft dry, sinking resumed.	
May 2, 1913, water struck	8,606.00
Mar. 1, 1914, water struck	8,535.00
Jan. 20, 1915, water struck	8,425.00
Total drainage in 50 months	434 ft
Average drainage per month	8.7 ft

The driving of the drainage tunnel has presented no particular engineering difficulties, being more a test of financial strength and endurance. The section of the tunnel is 10 ft. wide by 7 ft. high, with a ditch on one side 3 ft. deep by 6 ft. wide, leaving a shelf 4 ft. wide on the other side for tracks and passage way. The grade is 0.3%. An intermediate shaft was sunk about 700 ft. to the level of the tunnel, and after October, 1908, work was carried on in both directions from the bottom of this shaft, simultaneously with the work from the portal. In July, 1909, a connection was made between the portal heading and the south heading from the shaft. Water-Leyner drills were used; and the haulage was done by mule-power. The average cost under the Carlton contract was, as has been stated, $27.27 per foot; the cost by months is given in the accompanying table:

COST OF DRIVING SHAFT HEADINGS

Month	Footage	Total Cost	Cost per Ft.
Oct., 1908	49	$5,170.46	$105.520
Nov.	141	6,254.25	44.380
Dec.	177	7,099.45	40.110
Jan., 1909	261	6,280.45	24.060
Feb.	601	14,246.56	23.700
Mar.	639	16,777.40	26.256
Apr.	670	16,763.94	25.020
May	552	15,642.87	28.340
June	498	13,632.46	27.375
July	319	10,486.05	32.871
Aug.	410	11,377.35	27.747
Sept.	355	11,502.21	32.400
Oct.	380	10,708.21	28.178
Nov.	298	10,191.96	34.200
Dec.	251	8,823.21	35.153
Jan., 1910	282	8,127.36	28.820
Feb.	259	7,934.92	30.636
Mar.	344	9,501.43	27.620
Apr.	376	9,517.64	25.313
May	393	9,768.58	24.856
June	373	9,927.75	26.616
July	350	8,836.47	25.247
Aug.	372	9,310.98	25.029
Sept.	342	9,731.03	28.450
Oct.	372	10,178.47	27.361
Nov.	192	5,335.09	27.786
	9,256	$263,126.55	

COST OF DRIVING PORTAL HEADING

Month	Footage	Total Cost	Cost per Ft.
Feb. and Mar., 1909	514.2	$11,667.77	$22.690
Apr.	262.0	8,113.89	30.970
May	268.0	7,232.52	26.760
June	187.0	6,548.16	35.010
July	203.0	6,045.31	29.600
Aug.	300.0	6,527.71	21.760
Sept.	351.0	6,877.25	19.600
Oct.	287.0	6,601.67	23.000
Nov.	360.0	7,604.59	21.120
Dec.	334.0	6,127.46	18.350
Jan., 1909	435.0	7,139.81	16.410
Feb.	290.0	6,439.98	22.206
Mar.	340.0	7,053.24	21.745
Apr.	316.0	6,720.07	21.266
May	402.0	7,542.19	18.762
June	62.0	2,516.21	40.600
July, finishing ditch		1,132.44	
	4,911.2	$111,890.27	

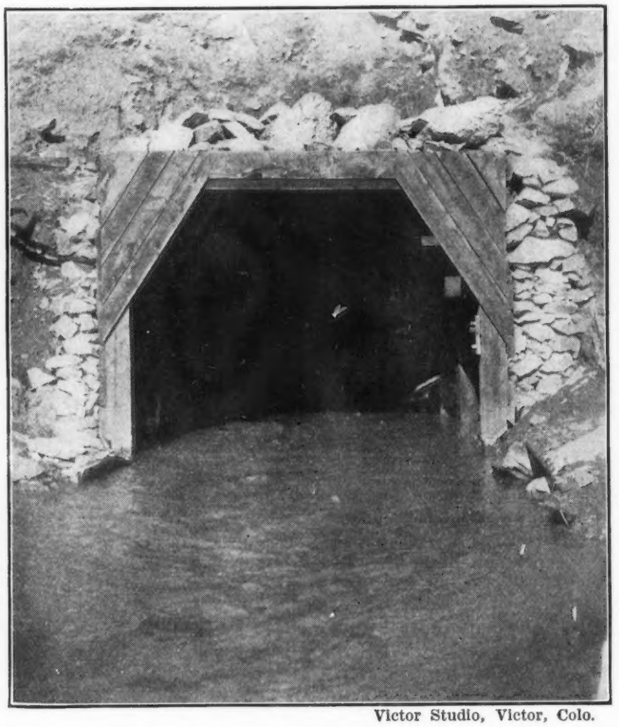
RECAPITULATION

Cost of portal work	$111,890.06
Contractor's percentage	11,404.88
Total cost of portal wor	$123,294.94
Cost of shaft work	263,126.55
Total cost of tunnel	$386,421.49
Total number of feet driven	14,167.20
Average cost per foot of tunnel	$27.27

The following itemized expenses are given for the month of July, 1908, in the portal heading, as a fairly representative month (from Bulletin 57, United States Bureau of Mines):

	Cost per Foot of Tunnel
Machinery and repairs	$0.61
Air drills and parts	0.99
Picks, shovels and steel	1.90
Ditch men	1.09
Explosives	6.90
Candles	0.36
Oil and waste	0.09
Electric power	2.06
Blacksmith supplies	0.09
General expense	0.16
Liability insurance	0.17
Lumber, ties and wedges	0.01
Horses and feed	0.01
Compressor men	1.79
Drillers and helpers	4.21
Blacksmiths and helpers	3.43
Muckers and drivers	4.11
Foremen	1.50
Bookkeeper	0.12
	$29.60

The rock up to the contact was hard, tough, Pike's Peak granite. No veins or unusual formations of any importance were encountered, and no water impeded the work until the main course was struck.



Victor Studio, Victor, Colo.

PORTAL OF TUNNEL, 11,000 GAL. PER MIN. FLOWING

This year a great deal of interest on the part of mining men is being centered in the Cripple Creek district, and this interest has been stimulated in no small degree by developments on the lower levels of the larger mines, made possible by deep drainage. The only large mines not directly benefited by the drainage tunnel are the Vindicator and the Golden Cycle, both now owned by the Vindicator company, although they have contributed heavily to the drainage project. Pumping is now costing the Vindicator company about $4,000 a month to drain both mines. A battery of three triplex electric pumps,

each driven by a G. E. 150-hp. motor, is installed on the 18th level of the Cycle shaft, a depth of 1,900 ft. from the surface, or 8,173 ft. above sea-level—only 60 ft. above the level of the drainage tunnel when it reaches this mine. When lower levels are opened, in the future, it will be necessary to pump only up to this level. The pumps are now handling about 500 gal. of water per minute.

In order to avoid this heavy pumping expense, the Vindicator company is particularly desirous of seeing the drainage tunnel pushed through to its territory, although all the other deep mines in the eastern part of the district are also interested to no small degree, as the prosecution of the tunnel means more rapid drainage in their shafts.

The fulfillment of this desire seems only a question of time. The money has all been either raised or pledged. Charles H. Fuller, who did some very creditable work on the Carlton contract, will have charge of the underground work, and T. R. Countryman, of Cripple Creek, will be the engineer. It is estimated that two years and an expenditure of $200,000 will be required to complete the tunnel.

In connection with some of the facts and figures here given, I wish to acknowledge the assistance of Irving T. Snyder, A. E. Carlton and his secretary, Virgil H. Mann; and my indebtedness to T. R. Countryman for the use of the maps, and to Victor G. Hills' paper published in the Portland company's ninth annual report.

Steel Production in Canada

The details of the production of steel in Canada for 1914 and preceding years are given in the preliminary report of the American Iron and Steel Association, as below, in long tons:

	1912		1913		1914	
	Tons	%	Tons	%	Tons	%
Openhearth	645,062	75.6	768,663	73.7	549,716	79.2
Bessemer	207,569	24.3	273,391	26.2	144,447	20.8
Other	400	0.1	449	0.1	284	...
Total	853,031	100.0	1,042,503	100.0	694,447	100.0

The total in 1914 included 675,691 tons ingots and 18,756 tons direct castings. In that year there were 4,800 tons of alloy-treated castings and ingots included.

Finished Iron and Steel

The production of finished rolled iron and steel in Canada for four years past has been, in long tons:

	1911	1912	1913	1914
Steel	695,541	752,212	871,216	612,210
Iron	86,383	109,012	95,881	47,309
Total	781,924	861,224	967,097	659,519

The production in 1914 included 218,125 tons plates, sheets, bars, etc.; 59,050 tons structural shapes and wire rods; 382,344 tons rails. Of the rails 211,490 tons were over 50 lb. and less than 85 lb. per yard; 149,549 tons 85 but less than 100 lb.; 21,305 tons over 100 lb. per yard. Included in the total were 1,548 tons of alloy-steel rails.

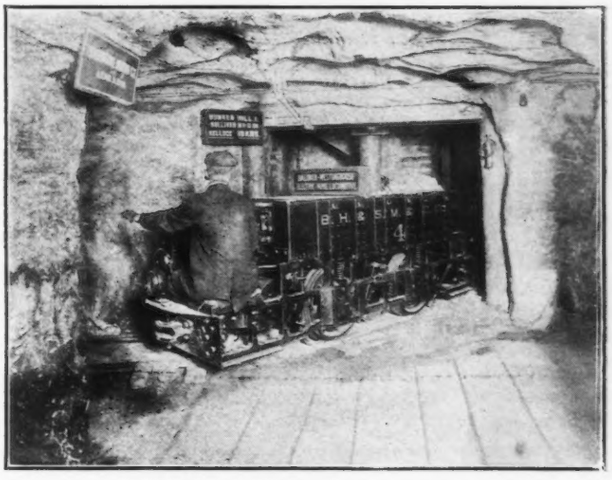
Miscellaneous Production

The total production of iron and steel cut and wire nails in Canada in 1914 was 1,144,000 kegs of 100 lb. each, which compares with 1,520,000 kegs in 1913. The output of finished splice bars, other rail joints and fastenings, not including spikes and bolts, in 1914 was 34,165 long tons, as compared with 54,839 tons in 1913. The make of forgings was: Iron, 1,792 tons; steel, 6,346 tons; total, 8,138 tons, a decrease of 15,267 tons from the preceding year.

The Mine at the Panama-Pacific Exposition

It is peculiarly fitting that the mining industry should be unusually well represented at San Francisco, because of the important part that mining has played in the development of the resources of California. So today the visitor at the Panama-Pacific Exposition has an opportunity to see practically at first hand the development of one of our greatest assets—our underground wealth—and at the same time inspect a mine without any of the discomforts usually attending such a visit. The Bureau of Mines of the Department of the Interior has, through the active and unselfish coöperation of a number of manufacturers and operators of mining equipment, established an exhibit that easily ranks as one of the most interesting of the exposition. Quoting from a pamphlet issued by the Bureau of Mines describing the exhibit:

"This exhibit, as its name implies, is an actual reproduction of full-size entries, drifts, stopes and rooms,



IN "THE MINE," PANAMA-PACIFIC EXPOSITION

selected from typical mines in various parts of the United States. In the several rooms of 'The Mine' are installed the appropriate machinery and appliances used in the modern mines. Visitors who expect to see in the mine ancient appliances famed in story, as the mine mule, the gray-bearded miner with pick and candle, black blasting powder and unventilated working places will be agreeably disappointed to find here a model mine, designed and operated under such modern working conditions as are best calculated to assure the safety and health of the miners as well as efficiency of operation.

"The mine may be entered either by way of a cage down the shaft or by walking down the slope. The former is a realistic representation of a mine cage descending the shaft. The visitor enters through a typical housing and sees a panoramic effect of neighboring mines and settlements. As the cage door is closed he experiences the sensation of descending the mine, slowly at first, then faster until full speed is attained. Cribbing, timbers backed with lagging, then rock strata, and deeper and darker are

seen two entries with miners working. The illusion is produced by the canvas walls of the cage being caused to move past the occupant, and the illusion of rapid descent is greatly accentuated by means of a current of air blown upward through the cage, both the panorama and the blower being operated by a 5-hp. Westinghouse motor. Finally, the cage appears to slow down and then stop, whereupon the opposite door to that which the visitor entered is opened and he is allowed to leave and proceed through a darkened tunnel to the mine under the impression that he has descended to a considerable depth, while as a matter of fact he leaves on the same level as he entered.

"Once in the mine, there is a vast number of interest-compelling exhibits. Ore brought from its native state and the setting reproduced at great pains and expense make the visitor feel as if he were really in a mine. Great credit is due to some of the operating companies for their hearty coöperation in making this exhibit one of the features of the exposition. Some of these have expended large sums of money and the services of expert engineers in reproducing sections of mines on their properties with great accuracy and detail. The timbering used was all taken from actual service in different mines—not 'made for the occasion'—and it bears the earmarks of years of good service. Space does not permit a description of all the exhibits in the mine, but a few of the more important may be mentioned: Mining in the gold mines of Nevada; at Lead in South Dakota; silver in Idaho; copper in Arizona and iron ore in Minnesota are among the representative operations shown."

American Mining Congress in San Francisco

The probability of the United States becoming the leading radium producer of the world and of reduction from the present price of $160,000 a gram to $40,000 was announced Sept. 20 by Van. H. Manning, director of the United States Bureau of Mines, speaking at the opening session of the American Mining Congress in the Civic Auditorium. In part he said:

The only fields of carnotite ore known today are in Colorado and Utah. These fields are not inexhaustible, and it is highly desirable that the Government take action that will prevent so much of this ore as now remains in its possession from being wasted or monopolized.

He also stated that in the West losses through wasteful methods in the mining of zinc were startling, but that through investigations of the mining bureau many undeveloped fields can now be operated at a profit. He also predicted the mining of tin as a new industry for California, Idaho, Washington, Wyoming and Alaska.

Dr. George Otis Smith, director of the Geological Survey, delivered a plea for "Plain Writing" in the preparation of scientific papers, and said that it is now the spirit in Washington to prepare Government reports in the "language of the people."

A message from President Wilson expressing regret at his inability to attend the Mining Congress, was read. Among the delegates who spoke before the convention were: Prof. Charles F. Willis, of Arizona; Dr. William B. Phillips, president of the Colorado School of Mines; Gardner F. Williams, of Washington, D. C.; John P. Reece, of Illinois; R. C. Allen, of Michigan; Otto Ruhl, of Missouri; Henry L. Day, of Idaho; George H. Utter, of New Mexico; Dr. J. E. Talmage, of Salt Lake, and Judge J. H. Richards, of Boise, Idaho.

Memorial exercises in honor of the late Dr. Joseph A. Holmes, director of the United States Bureau of Mines, were held on Tuesday morning, Sept. 21.

Among the prominent mining men who spoke in praise of Doctor Holmes were: Carl Scholz, of Chicago, president of the American Mining Congress; Van. H. Manning, director of the United States Bureau of Mines; William L. Saunders, of New York, president of the American Institute of Mining Engineers; M. L. Requa, of the Mining and Metallurgical Society of America; John P. Reece, of Illinois, president of the American Mine Safety Association; Herbert M. Wilson, president of the National Safety Council; Hennen Jennings, of Washington, D. C.; J. F. Callbreath, secretary of the American Mining Congress; Charles L. Dignowity, of Boston; Joseph Hyde Pratt, of North Carolina; E. L. Bartholomew; Dr. J. E. Talmage, of Salt Lake City, and J. W. Paul and George S. Rice, of Pittsburgh, Penn.

At the regular morning session of the Mining Congress in the Civic Auditorium an address was delivered by Rush C. Butler, of Chicago, on the subject, "Constructive Regulation of Business," which topic was discussed in detail by the delegates. The afternoon session was taken up with an address on California's water-infiltration law, by Fletcher McN. Hamilton, state mineralogist of California, followed by a technical discussion.

The following directors were elected to serve three-year terms at the evening session, held at the Palace Hotel: Dr. J. E. Talmage, of Salt Lake; Charles M. Moderwell, of Chicago; Harry L. Day, of Idaho, and Dr. W. B. Phillips, of Colorado. It was decided to hold the next annual convention of the Mining Congress in Chicago. A banquet was held Tuesday evening at the Palace Hotel by the congress as a testimonial to Van. H. Manning, director of the United States Bureau of Mines.

The Wednesday session brought out more lively discussion than did those of the preceding days.

Harry L. Day, of Wallace, Idaho, president of the Federal Mining and Smelting Co., declared that two-thirds of mine accidents are due to the "criminal carelessness" of workers. Dr. Frederick L. Hoffman, the insurance-company statistician, well-known to *Journal* readers by his many contributions, said that the mine operator is responsible in the last analysis for most accidents and disease-spreading conditions.

Herbert M. Wilson, of Pittsburgh, Penn., director of safety for the Associated Mining Companies, agreed with Dr. Hoffman, who recommended an investigation into underground sanitary conditions of mines on the Mother Lode of California with the view of combating the hookworm disease.

A resolution was adopted protesting against the restrictions imposed by the Department of the Interior in granting rights of way over public lands.

The following program was carried out:

Report of committee on freight and ore treatment rates by Imer Pett, chairman, of Salt Lake City; address, "The Future of the American Zinc Industry," by Otto Ruhl, of Joplin, Mo.; "The Development of Mine Taxation in Arizona," by G. H. Dowell, of Bisbee, Ariz.; "The Need of Better Mining Education," by Prof. Charles F. Willis, of Tucson, Ariz.; "Workman's Compensation Insurance and the Coal Mining Industry," by Herbert M. Wilson, of Pittsburgh, Penn.; "The New Plan of Mining Insurance," by David Ross, of Springfield, Ill., and "Mining Hazards of the Pacific Coast," by Dr. F. L. Hoffman, of Newark, N. J.

Some Points in the Economics of Zinc Metallurgy*

SYNOPSIS—A comparison of the chief differences between American and European practice in so far as the main economic points are concerned. The powerful effect of the great supply of Australian zinc ore upon the spelter industry of the world. Prospects for zinc smelting in remote countries.

Even before the war began, the zinc industry of the world was experiencing radical changes. The effect of the war will be to produce more changes, whereof no man can yet clearly foresee the nature and scope. Looking backward, we can now perceive that 1896, when the Wilfley table was introduced, was a historic date in the metallurgy of zinc. Making possible an improved concentration of mixed ores requiring fine grinding, the first step in the solution of the long-baffling mixed-ore problem had been taken and the smelters were offered a new and bountiful supply of lead-bearing zinc ore, often high in iron, to which they had to adjust their metallurgy. Another important step in the separation of mixed ores occurred subsequently, with the introduction of Wetherill's system of magnetic separation and Blake's system of electrostatic separation, but the climax occurred with the successful introduction of the flotation process at Broken Hill.

Effect of Flotation at Broken Hill

The development at Broken Hill had at least three great consequences: It standardized smelting practice in Belgium and Germany; it compelled nearly all of the smelters of those countries to go on a zinc-lead basis; it showed that mixed ores could be profitably treated and caused a search for them to be made in all parts of the world, which within a few years resulted in the development of such mines as the Butte & Superior, of Butte, Mont.; the Bawdwin, of Burma; and the Riddersk, of Siberia, to mention only three of the first order.

Let me be more explicit respecting these statements. The total zinc production of the world in 1913 was about 1,000,000 metric tons, of which Belgium, Holland and Germany produced about 500,000 tons. Broken Hill in 1910-12 produced an average of 450,000 tons of blende concentrate per annum, averaging 46 to 47% zinc, which may be roughly calculated as equivalent to a yield of 170,000 tons of spelter, or about 35% of the total of Germany and the low countries.

The Market for Broken Hill Concentrates

The immense Australian ore supply was contracted to the three great German metal-merchandising firms, which distributed the ore among the smelters of Germany and Belgium. Those smelters coming thus into possession of so large, so uniform and so regular a supply of ore, the like of which in none of those respects had ever previously been experienced in the zinc industry, were able to standardize their smelting practice, not only as to a single works, but also as to many works, which was metallurgically beneficial.

Leady Zinc Ores Now a Matter of Course

The Broken Hill zinc ore was rather high in lead. In previous times zinc smelters generally were averse to smelting ore containing more than 2 or 3% of lead, although there were a few smelters who made a practice of treating ores relatively high in lead and recovering a considerable proportion of the lead therefrom. With the advent of the Broken Hill ore, the recovery of lead as a byproduct in zinc smelting became the regular thing; and in fact, the smelters of Belgium and Germany went practically upon a zinc-lead basis and even became insistent upon having a percentage of lead present in their ore that was far above what in earlier years had been regarded as permissible.

Zinc Smelting Becoming a Widely Distributed Industry

Another radical change in the zinc industry, that was in progress previous to the war, involved the establishment of new loci of zinc smelting and was rather directly connected with the Australian development. The art of zinc smelting is one of a multiplicity of details in which the part played by many workmen spells the difference between success and failure. No matter how careful the plans of the engineer may be, they are likely to come to naught unless there be good workmen to carry them out; and the making of good workmen requires long training. The possession of a class of workmen which has been engaged in zinc smelting during several generations is one reason why Belgium continued to be a great zinc-smelting country long after its own resources were exhausted. And because of the absence of such a class of smelters, it has been universally the experience that the inauguration of new zinc-smelting enterprises in new regions has been attended by difficulties which generally have wrecked the adventurer. With the advent of the great Australian ore-producing interests, however, there entered into the zinc industry a group of concerns with financial resources that enabled them to build zinc-smelting works in any logical location and with equanimity to carry them through the period in which the native population had to be taught how to smelt zinc ore. Thus we have already witnessed the erection and operation of two zinc smelteries in Australia, we have seen the foundations laid for a great zinc smeltery far away in Siberia, and we have reason to believe that ere long a zinc smeltery may be erected at some seaport of India. In the meanwhile, the Japanese, with their customary adaptiveness, have inaugurated zinc smelting within their empire. There were, therefore, plans on foot that promised to make the art of zinc smelting one of far wider application than it had ever been during the century of its commercial history. These conditions were fully in evidence before the war began.

Germany, by virtue of its own great deposits of zinc ore in Upper Silesia and its contracts for the Broken

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Hill ore, was the great purveyor of spelter to the rest of Europe, especially to England. The first great consequences of the war were to suspend, to a major extent, the production of zinc ore in Australia, there being insufficient surplus smelting capacity outside of Germany and Belgium to receive it, and to throw a large part of the spelter requirements of Great Britain, France and Russia upon the United States, the result of which was to raise the price for spelter to a figure not previously recorded in many years. What other major and minor effects the disturbance of the war may have upon the spelter industry lie within the sphere of prophecy. I will venture no more than the suggestion that they will be profound.

The world's great districts of zinc smelting have heretofore been Upper Silesia and Rheinland-Westphalia, in Germany; the valley of the Meuse and the Campine, in Belgium and Holland; and Kansas, Oklahoma and Illinois, in the United States. The art of zinc smelting was first introduced (from China) into Great Britain, but the British smelters have not, during the last 100 years, been leaders in the art, nor has zinc smelting attained great magnitude in their land.

During the last 50 years, there have been three types of zinc smelting (the earlier English and Carinthian processes having disappeared), which are known as the Silesian, Belgo-Silesian, and Belgian. In recent years, the Belgo-Silesian method has become known as the Rhenish, and this has shown a strong tendency to displace the Belgian process in Belgium and an even stronger tendency to displace the Silesian process in Silesia. The reasons for this are discussed in the metallurgical treatises, of which zinc smelting has recently acquired a rich literature. They may be summarized as a superior economy, as compared with the Belgian furnace; and, in Silesia, a change in the character of the ore which causes this method to be better adapted than the Silesian furnace. In the United States, the method of smelting is essentially the Belgian, which has been modified to conform to peculiar conditions.

Variations in American and European Practice Due to Labor and Material Prices

Considering the art of zinc smelting upon its broadest lines, the variations between European and American practice are explained by variations in fundamental conditions, which may be summarized in the statement that in Europe labor is cheap and coal is dear, while in the United States coal is cheap and labor is dear. Thus we find American smelters striving ever for mechanical substitutes for hand labor and European smelters aiming always to reduce coal consumption. There have been other determinative factors, the differences among which are, however, tending to disappear. One of these is permanence of the smelting districts. Another is scientific attention to the art.

Zinc smelting was begun in Upper Silesia in 1798 and on the Meuse in 1807, and ever since those dates has been conducted in those districts. Their metallurgical stability has induced operators to build substantially. From an early date, moreover, the smelting was directed by educated metallurgists, and both in French and German is there a literature extending backward for a century. In the United States, on the other hand, only two works—those at La Salle and Peru, in Illinois—have a long history and in the main the zinc-smelting industry has been characterized by shifts and uncertainties that stifled ideas of permanent building. About 1871 zinc smelting was begun at Pittsburg, Kan., and for 30 years was conducted with an absurd disregard of scientific control. Not until about 1898 were chemists employed, even to assay the ores bought and smelted. Ore was cheap, and for three decades the precept was "better butcher the ore than butcher the furnace." About 1901 most of the smelteries in this district were scrapped and the Iola district, where natural gas occurred, became paramount. Ten years later Iola was the scene of deserted works and the star of Bartlesville and Collinsville, in Oklahoma, was ascendant, but even now it is waning and the great locus of zinc smelting is becoming the coal fields of Illinois and further eastward. With this last move zinc smelters show that they are building for permanent business, not merely to reap some ephemeral natural advantage, and with the utilization of the services of metallurgists (which has been general only within the last 10 or 15 years), certain differences between European and American results are tending to disappear.

Sulphuric-Acid Recovery More Marketable Abroad

One other basic condition requires mention. European smelters operate generally in highly developed industrial regions affording a market for sulphuric acid and rendering the free discharge of sulphur smoke unpermissible anyhow. Therefore European smelters long ago began to make sulphuric acid as a byproduct of blende roasting. American smelters, on the other hand, were able to emit their smoke without doing great harm and had no market for acid. Consequently they did not make it. This condition, also, is undergoing radical change. Every smelter of blende east of the Mississippi River now makes acid.

In many respects the development of the American zinc-smelting industry has exhibited absence of initiative and curious contradictions. Our two great names are Wetherill and Hegeler. The former invented the process of making zinc oxide direct from ore. The latter introduced the first successful mechanically raked muffle furnace for blende roasting, modified the Belgian distillation furnace and introduced many mechanical contrivances. The best American zinc-smelting practice of the present day follows very closely in Hegeler's footsteps, with certain improvements borrowed from Belgium and Germany.

Early Introduction of Mechanical Roasting

During the last 20 years the vogue of the mechanical furnace for blende-roasting, in the United States has become all but universal. At the present time our works have capacity for roasting about 800,000 tons of blende per annum, and only two or three examples of the old hand-roasting kilns survive. Yet, of our mechanical furnaces, the Hegeler dates back to 1884, and during the last 15 years there has been no introduction of any new type—an emphatic commentary upon the absence of originality that has heretofore characterized zinc smelting in America. In the meanwhile the Germans have exhibited much alertness in developing and adopting mechanical roasting furnaces in spite of their lower rates of wages and consequent lack of incentive to substitute machines for men.

I may best elucidate further comparisons between European and American practice by sketching the principal parts of a modern zinc-smelting works. In all of what follows in this paper I have in mind only the smelting with coal-fired furnaces, dismissing from attention the smelting with natural gas in the United States, which is on the wane. Nor are the figures that I give intended to represent the practice with Silesian furnaces in Upper Silesia, Germany.

The ore is delivered into the works in railway cars, from which it is unloaded directly into the storage bins. The means for unloading, sampling, storing and reclaiming have, heretofore, been rather crude in many of the American works, but recently there has been an increasing tendency to adopt the superior methods that have long obtained among lead and copper smelters.

The ores coming to the zinc smelter are classified as calamine and blende. In Europe the former is still calcined. In America the calcination of calamine was abandoned by the smelters may years ago, the advantages being pronounced unequal to the cost. Blende, of course, must always be roasted. In America we use the Hegeler furnace if sulphuric acid is to be made; otherwise, simpler forms of mechanical furnace. Our object is mainly to save labor. In Europe hand-raked furnaces of the Rhenania, or the later Delplace, type are commonly employed, which are both designed and operated to save coal. The dead-roasting of blende has been regularly effected with a coal consumption of only 10% of the weight of the ore, a lower figure than has ever been achieved in the United States. However, there is a growing usage of mechanical roasting furnaces in Europe and an adoption of such new and excellent types as the Merton and the Spirlet, which American smelters have not yet ventured to try.

The roasted ore goes to the mixer, where it is united with the proper proportion of reduction coal. Mechanical mixing and careful attention to this important part of the process were early practiced at La Salle, but elsewhere in the United States this was generally done in ways far below European standards until recently. However, we are no longer subject to such a reproach.

Variations in Design of Works

Following European practice, our distillation furnaces are now commonly built entirely above the ground, the unclean, uncomfortable and unsanitary subterranean galleries of old being abolished. The Europeans are still ahead of us, however, in ventilation of the furnace houses. The Europeans generally lay out their furnaces in line. We lay them out in rows. The Europeans commonly employ recuperative (both reversing and counter-current) furnaces—again with view to economy of coal—and succeed in smelting a ton of ore with as little as a ton of coal. In the United States we use mostly the long Hegeler furnace. With natural gas firing there is no heat recuperation. With coal firing the economizing of fuel takes the form of generating steam from the waste gases. The long furnaces and the steam-boiler accessories are distinctly American, and both are due to Hegeler. To Hegeler also is due the charging car, metal-drawing car and other mechanical contrivances in aid of the work about the distillation furnaces. The only successful mechanical chargers, however, are of European origin; but a recent American invention of some promise is a mechanical discharger. A distinctive feature of American distillation-furnace practice is the use of blowers for the delivery of the combustion-air to the furnaces.[1]

In the manufacture of retorts the hydraulic press, which originated in Belgium, is now commonly employed both in Europe and America. However, the Europeans give more attention to the manufacture of their retorts and unquestionably make a better retort than we do.

In the handling of material in the works the modern American plants are as well equipped with tramways, elevators, etc., as are lead smelteries of corresponding size. In this respect our best American plants are in no wise inferior to the best European.

European smelters have long recovered lead and silver from their retort residues. American smelters now do so to a considerable extent, but the treatment of lead-bearing ores and recovery of the lead is less a feature of American practice than it is of the European. American zinc smelters pass the whole of their residue to the lead smelters. European zinc smelters commonly concentrate it by jigs and tables and deliver a lead concentrate for smelting.

European Distillation Temperatures Higher Than American

Metallurgically, the essence of zinc smelting is the temperature of distillation. Speaking generally, the higher the temperature the better is the extraction of zinc. But with bad ores and bad practice high temperature is infeasible; for the furnaces and retorts will not stand it. A bad ore may be smelted with but little trouble, at a relatively low temperature, but the extraction of zinc will be poor. The aim of the zinc smelter is to smelt a bad ore and obtain the maximum possible percentage of zinc out of it.

In general, the Europeans excel the Americans in this respect. They mix their ores more scientifically, they make better retorts and they build stronger furnaces, all of which contribute to an ability to drive their furnaces at higher temperature than Americans have yet attained, and at the same time they manage with ores that are rather high in lead. In so smelting, they make a leady spelter, but a simple refining in a reverberatory furnace removes the excess lead. In only one American works is that practiced.

European smelters also generally recover blue powder as a commercial product. This is obtained from the prolongs, which condense a proportion of zinc that would otherwise be lost. American smelters do not use prolongs. Although in trials of them, an additional 1 or 2% of the zinc has been obtained, they have found it to be unprofitable—this again reflecting the difference in labor conditions.

I have outlined the main differences between European and American practice in zinc smelting. They are explained by the reasons previously mentioned. Per ton of raw sulphide ore the American smelter uses about 2 to 2½ tons of coal and 2 or 3 man-days of labor, and extracts about 84 to 88% of the zinc that is in his ore;

[1]Let it be noted that in offering these broad generalizations of comparative European and American practice, it is well in mind that there are representatives of several furnace types in the United States. Thus are to be found Siemens-Belgian furnaces at Peru and Depue, Overpelt-Rhenish furnaces at Pueblo, and counter-current recuperative furnaces at Palmerton.

if he treats lead-bearing ore, he may recover 50 to 60% of the lead.[2]

The European smelter uses about 1¼ to 1¾ tons of coal and 3 to 3½ man-days of labor, and extracts 88 to 90% of the zinc that is in his ore, and about 50 to 70% of the lead.

I hope to disarm criticism of these figures by stating that such figures properly should be accompanied by qualifications and explanations that would run to pages in length and would constitute a condensed treatise upon the metallurgy of zinc; and that I offer the figures that I have used merely as broad generalizations for the purpose of exhibiting, in tabloid form, the lessons deduced from the differences in the art as practiced in Germany and the low countries and in the United States. They mean that the Europeans, with the aid of better furnaces and superior technical direction, are able to smelt more refractory ore than we Americans, and yet extract a higher proportion of the valuable metals. They have built more substantial plants—secure from fear of geographical migration of their industry—for the sake of increased durability and maximum economy of fuel. While the rates of wages are higher in the United States than in Europe, American zinc smelters have not been able to offset that by the development of superior efficiency in the ways that the copper and lead smelters have done. Man for man, the German and Belgian smelter does as much work as the American. Thus the attendance of the distillation furnaces in Rheinland and Belgium requires 1.75 to 2.5 man-shifts per ton of roasted ore, while in America the requirement is 1.75 to 2.25. The difference in labor in roasting is insignificant when mechanical furnaces are employed. Such economies in labor as America has effected have been chiefly in the handling of material, which, in zinc smelting, is a relatively small part of the process.

Zinc Smelting Not So Backward as Supposed

Before concluding this paper I am bound to refer to certain misconceptions that continue to exist respecting the status of zinc smelting and the possibilities of any radical changes happening in this art, such as have happened in lead and copper smelting.

The art of zinc smelting is far from being at a standstill. When we find 1,000 kg. of ore requiring 1,000 calories of heat being distilled with 1,100 kg. of coal equivalent to 8,000 calories, as is done in the best practice, we are observing a thermal efficiency of 12½%, which compares favorably with good steam practice. When we find a ton of ore being smelted with 2½ man-days of labor, and consider that we are dealing with a concentrated product, and reflect that the total weight of material handled is relatively small and that the work on it from step to step is often more cheaply done by a man than by a machine, we do not feel unduly mortified by our results. Nor does the extraction of only 85 or 90% of the zinc content of the ore shame us very much when we reflect upon the peculiar and troublesome metallurgical properties of zinc.

The Complex-Sulphide Problem

The so-called problem of the mixed sulphide ores that has engaged so much attention during 50 or 60 years is not a question of how such ores can be treated—for means have been known for a long time—but, rather, is it a question of how may such ores be treated with sufficient cheapness. This problem has been solved to a large extent by the improvements in the art of mechanical concentration (especially the flotation process) and the improved ability of the zinc smelter to treat plumbiferous and ferruginous ore. Yet there are still ores whereof the beneficiation is highly unsatisfactory, such, for example, as those ores which contain fluorite and those ores which are a crypto-crystalline mixture of the component sulphide minerals. The present treatment of zinc ores that are high in silver leaves much to be desired. For some of these ores it is possible that hydrometallurgical or hydrometallurgical-electrometallurgical processes may be useful in certain cases. There has been a commercial hydrometallurgy of zinc for many years, but it has not been extensive, simply for the reason that most ores could be more profitably treated in other ways. The precipitation of zinc from solutions by electrolysis used to be troublesome and unsatisfactory, but now that seems to have been mastered.

Electric zinc smelting, which has engaged a good deal of attention during the last 15 years, is metallurgically of the same nature as ordinary smelting; the main difference is that in one case the zinc is distilled by the heat of the electric arc or the heat of electric resistance, while in the other case it is done by the combustion of coal. So far, electric smelting has become an art only in Sweden and Norway, where several thousands of tons of spelter are annually produced by this method. The smelters in Sweden and Norway enjoy very cheap power, whereby they have been able to overcome, or at least meet, the main obstacle that has heretofore prevented electric smelting from becoming a commercial art elsewhere.

[2]The matter of lead recovery can be but vaguely stated, it being so intimately related with the original content of the ore and the manner of effecting the recovery. The main sources of loss are: (1) By volatilization during roasting; (2) by volatilization during distillation, a portion of which may be recoverable by refining the spelter; (3) in the tailings of the mill, dressing the retort residues; and finally there are (4) the ordinary losses of the lead-smelting furnace. As a debit against any lead that may be recovered under (2) is the cost of refining the leady spelter. Process (3) is a source of large loss and may be omitted, but then there is an increased weight of material to be treated by the lead furnaces and therefore a higher cost of smelting. Yet, here again there may be an offsetting condition, namely, the residues may be high in iron and the lead smelter may need iron. These few remarks will give an idea of the complexity of this subject, which is indeed incapable of accurate generalization. The only answer is that which is expressed in dollars and cents in each case. What applies to lead also applies to silver. In my generalizations of the requirements of coal and labor in zinc smelting, I have not included anything involved in the refining of spelter or in the treatment of residues remaining after zinc extraction.

Ontario Mineral Production in First Half of 1915

Supplementing the figures given in the *Journal* of Sept. 25, 1915, on Ontario mineral production for the first half of 1915, the following additional information is given. The quantity of nickel-copper ore raised was 548,579 tons, and the quantity smelted, 550,870 tons.

The chief outlet for cobalt oxide—the ceramic works of Europe—has been closed by the war. Consequently the shipments from the silver refineries have been greatly reduced, falling off in value 85%. Some consignments have been made to Great Britain and the United States. Metallic cobalt is now being produced both at Deloro and Thorold and is finding a use in the manufacture of high-grade and high-speed tools, also for the plating of metallic objects, replacing nickel for this purpose.

Tin-Ore Dressing at Llallagua, Bolivia--III

By Durward Copeland* and Scovill E. Hollister†

SYNOPSIS—The grade of tin "barrilla" made affects markedly the profit of the Bolivian producers, on account of the high freight and smelting charges. The tenor of various products of the Llallagua company is shown in an accompanying diagram. The cost of different operations and of supplies is also given in considerable detail.

The tin concentrates of Bolivia are shipped to Europe for smelting. Freights and smelting charges are heavy so the grade of the *barrilla* is of the greatest importance. This point, in regard to concentrates made, is especially true in times of depressed prices for tin. In fact, when tin is selling for a low price the grade of *barrilla* made may easily determine whether there is a loss or a fairly large profit to the producer. The majority of the Bolivian producers are satisfied with a shipping product containing 60% tin. An average of 65% in the *barrilla* is not common. The idea prevails that any attempt to increase materially the percentage of tin in the concentrate would be accompanied by a loss that would more than overcome any benefits obtained.

An accompanying diagram shows the relation of the tin mineral to the minerals which do not contain tin, in the mine ore, the mill tailings and in the concentrates produced by the company at Llallagua. The mill tailings are at present, because of increased regrinding of jig tailings and better classification, considerably lower in tin than is shown in the diagram. It is true that the higher the percentage of tin in the concentrates the higher the tin in the tailings and the greater the loss, but it has been found that allowing the *barrilla* to contain 10% of minerals which do not contain tin and nearly all of which are lighter than cassiterite is enough to afford a good protection against loss. There is, with a reasonably well managed mill, little more loss when the nonstanniferous minerals in the concentrates are reduced to 10% than when there is allowed to enter the *barrilla* 23% of minerals other than cassiterite. This is the same as saying that there is little more loss when producing a *barrilla* with 70% tin than when making one with only 60%. Diagrams have been prepared to show that by making 12,860 quintals of 70% *barrilla* rather than 15,000 quintals of 60% (there are equal quantities of fine tin in the two cases), there is an extra profit of at least 55,000 bolivianos. With the monthly production mentioned, each increase of 1% in the *barrilla* grade results in an extra earning of 6000 bolivianos.

ANALYSIS OF LLALLAGUA "S.S." BARRILLA

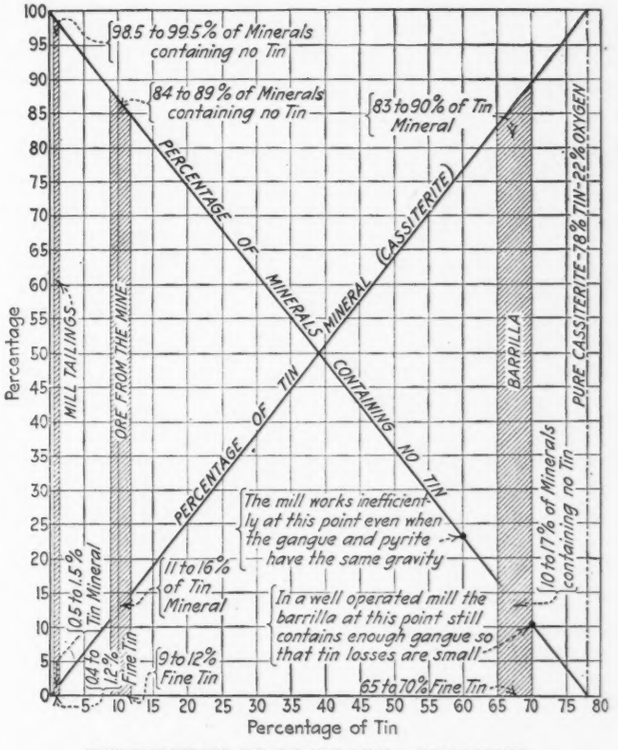
Tin oxide (68.32% Sn)	86.670
Iron	4.746
Nickel	0.023
Copper	0.060
Bismuth	0.360
Lead	0.070
Zinc	0.225
Silver	0.006
Titanium oxide	0.400
Tungstic acid	0.560
Calcium oxide	0.130
Silica	2.240
Sulphur	3.586
Oxygen and loss	0.924
	100.000

In an accompanying table are shown the results of a complete analysis made by Alfred H. Knight, of London, on a sample of *barrilla* of the class "S.S." This analysis was made in 1913 and represents the grade of concentrates as then made. With the present *barrilla*, averaging about 70% tin, the quantities of the metallic impurities are less than those shown in Mr. Knight's analysis.

Tin Assay by Cyanide-Fusion Method

In the making of uniformly high-grade concentrates, the various machines and sections in the mill require careful regulation. In order that this can be done effectively the company has a well-equipped laboratory. The substances in the *barrilla* of greatest importance in determining the profits to the company are the tin, sulphur, arsenic and copper, these being the elements upon which the smelting charges are based. Also, in the mine, payment to many of the contractors depends upon the percentage of tin in their ores, and these assays make fully 50% of the total work of the laboratory.

In Bolivia it is the practice to determine tin by the cyanide-fusion method, so the laboratory at Llallagua was


98.5 to 99.5% of Minerals containing no Tin
84 to 89% of Minerals containing no Tin
83 to 90% of Tin Mineral
PERCENTAGE OF MINERALS MINERAL (CASSITERITE)
PERCENTAGE OF TIN CONTAINING NO TIN
MILL TAILINGS
ORE FROM THE MINE
BARRILLA
PURE CASSITERITE-78% TIN-22% OXYGEN
0.5 to 1.5% Tin Mineral
0.4 to 1.2% Fine Tin
11 to 16% of Tin Mineral
9 to 12% Fine Tin
The mill works inefficiently at this point even when the gangue and pyrite have the same gravity
In a well operated mill the barrilla at this point still contains enough gangue so that tin losses are small
65 to 70% Fine Tin
10 to 17% of Minerals containing no Tin
Percentage
Percentage of Tin

COMPOSITION OF LLALLAGUA PRODUCTS

Diagram showing percentage of fine tin, tin mineral (cassiterite) and minerals containing no tin in the ore, the barrilla and the tailings.

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equipped to make the tin assays in this manner. In the cyanide-fusion assay the sample, after the soluble iron and other impurities which might enter the tin button have been removed by the use of acids, is mixed with "98%" potassium cyanide in crucibles and fused in a coke furnace for half an hour. The fusion being complete the crucible is removed, cooled and broken open, the tin button cleaned and weighed. At Llallagua a 10-gram sample mixed with 20 grams of cyanide is the charge. This is fused in a No. 6 Battersea crucible. On *barrilla* this method gives results uniformly 2% lower than those obtained by the smelters in Europe.

As Llallagua is so far from the markets (Europe and the United States) which can supply chemicals and laboratory equipment, it is necessary to keep on hand at least a year's supply of materials. By the time the freights and duties have been paid, any chemical, piece of glassware or apparatus we use has about four times the value it would have in the United States. This makes the cost of assays very high.

During the first eight months of 1914 an average of 1152 tin assays were made monthly at a cost per assay of 2.40 bolivianos ($0.83). Of this cost 8.8% was for crucibles, 43.2% for cyanide and acids, and 48% was for labor. This last item includes the cost of taking the samples and of preparing them for the laboratory. The cost to the laboratory of the various chemicals and materials is shown in the accompanying table:

MATERIALS USED IN LABORATORY IN AUGUST, 1914

Quantity	Article		Price	Value
1350	Crucibles No. 6	@	$0.07	$94.50
10	Scorifiers, 2½ in.	@	.05	.50
54 kg.	Nitric acid	@	1.90	102.60
45 kg.	Hydrochloric	@	1.71	76.95
31 kg.	Potassium cyanide	@	1.59	49.29
2 reams	Paper for samples	@	3.28	6.56
2 cans	Paraffin	@	2.72	5.44
1 drum	Benzine	@	17.24	17.24
1230	Sample sacks	@	.01	12.30
35 quintals	Coke	@	2.07	72.45
15 liters	Alcohol	@	.35	5.25
5 liters	Ammonia	@	1.55	7.75
All other chemicals				6.90
Office supplies				6.90
Total				$463.63

The assays for copper, arsenic, sulphur, and any special analyses for any of the departments are made by the methods employed in common laboratory practice. The one point worth noting is that these analyses cost as much proportionally as the tin assays.

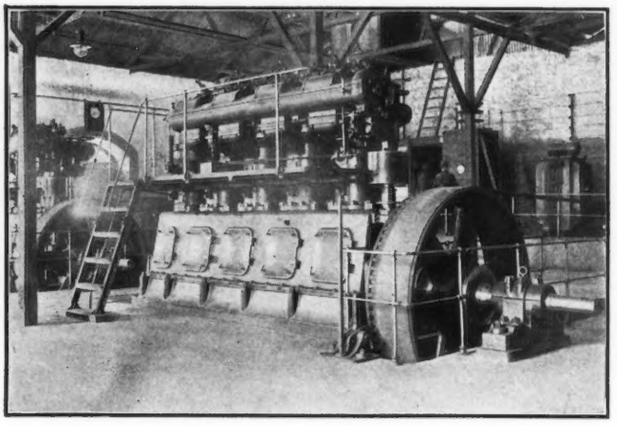
Three Power Sources

The power for the mine and mill is supplied from three power units. A hydro-electric plant capable of generating 800 hp. supplies that amount during nine months of the year, but is not in operation the other three months because of lack of water for the turbines, when power is supplied to the mine by two Diesel engines generating 400 hp. and the mill is run by a 200-hp. Deutz gas engine belted directly to the main transmission line. Power for the roaster-separator plant, machine shop and other power installations at the mill plant is supplied by a second Deutz motor. The entire electric system is connected through a central switchboard and current from any of the three sources can be supplied to any part of the system.

The first estimate of cost for building a 60-m. dam and equipping a hydro-electric plant to develop 450 hp. was 400,000 bolivianos ($138,000). By the end of 1914, because of washouts during construction and landslides into the river below the turbine house, the first cost for dam, overflow tunnels and an 800-hp. installation will amount to 1,350,000 bolivianos (about $470,000). By figuring the life of the mine as five years, a reasonable estimate, and charging 10% on the money invested, the first cost can be paid off in five equal yearly payments of 360,000 bolivianos. Calculating 600 hp. for 12 months (800 hp. for 9 months) the charge per horsepower-day for the first cost is $0.58. Operation and repair costs are as follows: Attendance, $0.025; repairs, $0.002; other costs, $0.002; total operating, $0.029. This makes a total cost for hydro-electric power of $0.58 + $0.029 = $0.61 per horsepower-day, which is 2.54c. per horsepower-hour. After five years, should the mine still produce, this power would be much cheaper, since the first cost of the installation would have been paid.

Diesel Engines at 13,000 Ft. Altitude

The Diesel oil-engine plant is rather interesting in that it affords some data on the operation of Diesels at high altitudes. The two engines installed at the elevation of the mill, 13,000 ft., are each rated at 300 hp. at sea level. The makers, Sulzer Brothers, Winterthur, Switzerland, would guarantee for them but 150 hp. at the elevation of the mine tunnel, 1000 ft. above



SULZER-DIESEL ENGINES AT LLALLAGUA

the point of their installation. At the beginning of the revolution of the Diesel engine the cylinder is filled with air at atmospheric pressure. This air is compressed to not less than 45 atmospheres and then fuel oil is forced into the cylinder. The temperature of the air due to the compression is so high that the oil immediately ignites. The amount of oil that can be burned at one revolution depends upon the weight of oxygen in the compressed air. Since the barometer here reads only about two-thirds as much as at sea level, one would expect the same engine running at the same rate to burn in a given time only about two-thirds as much oil and hence to develop not more than two-thirds as much power as at sea level. Our engines will each give about 200 hp. at this altitude. On actual tests made we have found that, using Peruvian crude oil of about 11,000 cal., the engines will produce when fully loaded 1 hp.-hr. with a consumption of 210 grams (0.463 lb.) of oil. For low fuel consumption the engines must be fully loaded. Using 210 grams of oil per horsepower-hour, the engines have a heat efficiency of 28%. Figuring that the first cost and interest on the investment at 10% should be charged off in five years, as in the case of the hydro-electric plant, with the difference

that we will say the Diesels produce 400 hp. 12 months of the year—since they can do so if necessary—we get the following:

The total cost of the Diesel engine plant, including the engines, generators, building, foundations (containing 200 bbl. of cement), freights and erection, was $52,000, of which the factory cost of the engines was $29,000. With interest at 10%, the principal and interest to be paid in five equal yearly payments, the annual charge will amount to $14,000. This is a cost of 9.6c. per horsepower-day. The operation and fuel costs for the Diesels are as follows: Fuel oil, $0.521 per horsepower-day; attendance, $0.016; cylinder oil, 36 kg. per day, $0.025; cleaning, $4.10 (extra) per month; repairs, $8.60 (extra) per month or $0.001 per horsepower-day; other costs, $17.20 (extra) per month or $0.001 per horsepower-day; cooling water, supplied by gravity; total operating, $0.564. The total cost for power from the Diesel engines from the above figures is 9.6 + 56.4 = 66c. per horsepower-day, which is 2.75c. per horsepower-hour. If the Diesel plant should be used after the five years, the cost per horsepower-day would still be at least 56.4c., the present operating cost.

Cheap Power from Deutz Gas Engines

The Deutz engines use gas generated from anthracite coal and produce power at a total cost of 3.8c. per horsepower-hour. Anthracite costs, at Llallagua, about $50 per ton. These engines were the first power units installed by the company that used anything but *taquia* for fuel and they have been giving excellent service for the last four years. They require cleaning only once in 60 days, and 12 hr. is sufficient for this operation.

Power costs being so high at Llallagua, some modifications are made in the methods of doing things. A horsepower-day developed by the Diesels costs more than the shift's wage of a laborer. It is poor economy to put in a machine needing 5 hp. to do the work that could be performed by two laborers per shift, for the company must have an investment in the machine and must pay for repairs, while the laborer represents no investment. When considering our automatic-roaster, magnetic-separator plant in comparison with the older hand furnaces and buddles, we always have to remember that the 20 hp. used in the new installation would pay the wages of more than 20 laborers (men and women) in the old plant.

The Cost of Doing Things

All machinery and nearly all mining supplies have to be brought to Llallagua from the United States or from Europe. Freights are a big part of the first cost of both machinery and supplies. The gateway to this section of Bolivia is Antofagasta, Chile, and from this port a 30-in.-gage railroad runs to Oruro. The nearest railroad station connected to Llallagua by a good cart road is Challapata, 60 miles from the mine. Ocean freights are cheap. On *barrilla* the rate per ton from Antofagasta to Europe is about £3 and it is expected that the freights through the Panama Canal to the United States will be lower. The rates on large shipments from Europe to West Coast ports are not nearly so high as £3. Considering the mountainous nature of the country and the high fuel cost the freight rates on the Antofagasta & Bolivian R.R. are reasonable, the cost per quintal from Antofagasta to Challapata, a distance of 500 miles, being about 2.80 bolivianos ($21 per ton). To bring material from Challapata to the mine when the weight is too great (that is, more than 100 lb.) for a llama, mule carts are used, and the cost per quintal varies from about 2.25 bolivianos ($15.50 per ton) for pieces of ordinary bulk and weight up to a much higher figure for articles which are especially heavy or bulky. Carts bringing in freight must be given *barrilla* for outgoing cargo even though rates for the same work by llamas are less. The cost of shipping on llamas is now cheap, it being possible to send a quintal of *barrilla* from the mine to Challapata for 1.10 bolivianos ($7.60 per ton). The carts make the 60-mile trip in three days. Llamas require five days for the journey from the mine to the railroad station.

Mining costs in many parts of Bolivia are dependent on freight rates. An instance is our cost of power from the Diesels. Of the total power expense 75% is for freights on the fuel oil and 40% is the cost of bringing the oil barrel from Antofagasta and returning it to the coast. It would make little difference in our power costs if the price of fuel oil at Antofagasta should go up or down 20%, since at Llallagua 80% of the final price is for freight.

Oregon lumber costs 35 centavos per board foot ($125 per M). A barrel of cement is worth 40 bolivianos ($14). Sheet iron costs 7c. per lb. An 18-liter can of Gargoyle lubricating oil has a value of 14.50 bolivianos or $5. We have a Hardinge mill. The first charge of pebbles came with the machine; these stones were valuable by the time they reached Llallagua.

Labor Now Plentiful

The price paid for labor in Bolivia varies greatly according to the place. In the last two years, because of high tin prices and great labor demand, the wages at Llallagua have constantly risen. A drill man received as high as 10 or even 12 bolivianos ($3.45 to $4.15) per 12-hr. shift and the average wage at the mine, including a considerable number of women ore pickers at 1.50 bolivianos and other cheap labor, was 6.30 bolivianos or $2.20. During the first part of 1914 the price of tin declined and with it the wage of the laborer. Then came the European war and practically no price for tin. Many small mines stopped operations. The nitrate fields of Chile curtailed. Railroad projects were stopped. Labor became plentiful and the average wage at the mine is now 3 bolivianos or $1, while at the mill it is about 1.98 bolivianos ($0.69) per shift of 12 hr. At ordinary times the labor is worth just about what we have to pay for it when the amount of work done for a dollar is compared with that performed for the same price in the United States.

The 12-hr. shift used at Llallagua and at Uncia does not mean 12 hr. of work. Custom rules in Bolivia and to the man who attempts to change things that are and have been, many things will happen. In occupations necessitating more or less strenuous work, such as shoveling, it is customary to set aside, each shift, three 20-min. periods for coca chewing. The coca-time is really a rest period as well and the laborer hunts a comfortable place to sit during the time. The custom of chewing the coca leaf is general. It should not cause more remark than the tobacco-chewing habit of the United States; it does not at all interfere with the pleasures of those who do not "chew." The coca seems to be exceedingly stimulating. An Indian eating a little grain and with coca to chew will run in a day distances almost incredibly great. In

traveling among the Indians in Bolivia the purchasing power of coca is more dependable than that of money.

The Bolivian laborer is usually contented and easy to handle. He will work hard and cheerfully. He would rather work for a small wage for a man he likes than for higher pay in the employ of a man he dislikes. He holds it an honor to have served one company for a long time. To his superior he is very respectful and often brings his domestic troubles to his employer for solution. When in charge of Bolivian labor it should always be remembered that, the men having been made to realize that you can be firm, all acts of kindness shown will be returned many-fold.

The costs for operating mine and mill are given in the accompanying table. The figures given are taken at times before the reductions of wages caused by the war were in full effect. With the present labor price the costs will be lower.

COSTS AT LLALLAGUA DURING JUNE, JULY AND AUGUST, 1914*

Item	Per Quintal of Barrilla Produced			Per Ton of Ore Milled			Per Ton of Rock Broken		
	June	July	Aug.	June	July	Aug.	June	July	Aug.
Mining Exploitation:									
Payroll	$1.90	$2.05	$1.81	$6.48	$6.41	$4.98	$2.59	$2.57	$1.99
Materials	.32	.25	.36	1.07	.78	.99	.43	.31	.39
Total	$2.22	$2.30	$2.17	$7.55	$7.19	$5.97	$3.02	$2.88	$2.38
Development:									
Payroll	1.28	1.05	.86	4.28	3.26	2.37	1.72	1.31	.95
Materials	.06	.02	.....	.21	.07	.....	.08	.03	.....
Total	$1.34	$1.07	$0.86	$4.49	$3.33	$2.37	$1.80	$1.34	$0.95
Total mining	3.56	3.37	3.03	12.04	10.52	8.34	4.82	4.22	3.33
Transportation to mill	.08	.08	.07	.26	.30	.20	.10	.12	.08
Milling:									
Payroll	.54	.56	.50	1.79	1.74	1.37	.73	.70	.54
Power	.18	.16	.12	.59	.50	.33	.24	.20	.14
Repairs	.08	.10	.09	.27	.31	.24	.10	.12	.09
Total	$0.80	$0.82	$0.71	$2.65	$2.55	$1.94	$1.07	$1.02	$0.77
New construction	.16	.20	.17	.54	.63	.47	.21	.25	.19
Barrilla sacks	.18	.18	.18	.61	.57	.50	.24	.22	.20
Assays	.06	.07	.08	.21	.22	.21	.08	.09	.08
Supply house	.02	.02	.02	.06	.06	.05	.03	.02	.02
Corral (20 animals)	.03	.04	.05	.10	.12	.12	.04	.05	.05
Costs of administration	.03	.02	.04	.10	.08	.10	.04	.03	.04
Legal matters	.06	.19	.07	.21	.58	.19	.08	.23	.08
Traveling expenses	.06	.04	.03	.19	.12	.08	.08	.05	.03
Office expenses	.10	.09	.10	.33	.29	.27	.13	.12	.11
Interest	.16	.....	.....	.55	.....	.....	.22	.....	.....
Insurance	.003	.003	.006	.01	.01	.02	.003	.003	.006
Commissions	.05	.....	.....	.17	.....	.....	.07	.....	.....
General expense	.07	.06	.09	.24	.17	.24	.10	.07	.10
Grand total	$5.26	$5.18	$4.47	$17.73	$15.59	$12.26	$7.10	$6.24	$4.90

* In these months approximately 40% of the ore broken and brought to the surface was sent to the mill.

One of the costs of mining in Bolivia which should not be overlooked is the export duty imposed on metals and concentrates, which for the most part go to other countries for use. One of the important incomes of the Bolivian Government comes from the duties charged on such exports. The duty on copper when the market is at 15c. a pound (£69 2s. 0d. per ton) amounts to $0.004 per pound of metal. Copper concentrates pay duties at the rate of 60% of those on the metal. Copper minerals which have not been concentrated pay 25% of the metal duty. This would appear to be an attempt on the part of the Government to discourage home concentration, although undoubtedly such is not the intention.

For wolfram the export duties are from 1.00 to 3.20 bolivianos per metric quintal when the London price per ton, with the basis of 60% tungstic acid, is from 20s. to 40s. per unit.

In the case of the duties on tin metal, they seem to be figured on the assumption that the amount of tin in a quintal of concentrates is two-thirds of that in a quintal of the metal and charges are made accordingly. This method of charging duties takes no account of the grade of the concentrates. When the price of tin in London ranges from £100 to £300, the export duties in Bolivia range from 2 to 14.55 bolivianos on concentrates and from 3.25 to 20.05 bolivianos on tin metal. The prices of the various metals in Bolivia are announced every 15 days by the government official with the title *Ministro de Hacienda*. The law of Dec. 1, 1911, which places a duty of 3% on the profits of all mining companies in Bolivia has been cancelled.

Investment Chances in Bolivia Good

Bolivia needs foreign capital for the development of its mining industry. The impression seems to prevail that money invested in Bolivian mines has not sufficient security and that it may be subjected to a multitude of actions at law. The fact is that where the titles of property are carefully secured, as would be the case in the United States, no trouble of lawsuits need be expected.

No large mining ventures have been started within the past five years. The country is well settled and in a way has been prospected by the Indians. Old workings of the Spaniards are found in many places. The system of Indian slavery practiced by the Spaniards permitted the working of deposits more cheaply than would at present be possible. There is in Bolivia good opportunity for North American investors. The chances for profit appear to be particularly good in the development of small mines, requiring but a moderate outlay of capital.

The Position of Tungsten

The following communication of W. A. S. Hellvar recently appeared in the London *Financial Times* on the subject of the scarcity of wolfram ores in the British Isles:

I have read the letter of O. J. Stannard in the "Times" of Sept. 4, and, as the part owner of a wolfram mine in Cornwall and a director of a tungsten-powder factory in London, I am perhaps qualified to offer some assistance to your correspondent in his dilemma when he states that he cannot "see why there should be this shortage of wolfram ore."

The ore is rarely produced free from tin, the output of a great number of producing mines containing up to as much as 10% of the latter commodity. Prior to the war 80% of the ore produced in or coming into Europe was consigned to Germany, including the whole of the tin-wolfram ore, for the reason that the Germans were the only people able to separate the tin from the wolfram. To be more explicit, Krupps, of Magdeberg, who were the makers of the Ullrich electromagnetic separator (a German machine), were open to buy tin-wolfram ore just as readily as they would take tin-free ore.

After the outbreak and as a consequence of the war there was no sale for mixed ore containing over 2% of tin, with the result that a large quantity of small native-owned mines in Burma closed down, and have not since restarted. At the present moment, instead of there being a difference of 1s. a unit between high-grade ore and that containing tin as pertained before the war, you have a difference of from 20s. to 25s. a unit. Only a few weeks ago a parcel of 30 tons of ore containing 8% of tin was sold in London at 31s. a unit, at a time when tin-free ore was fetching anything up to 60s. Metallic tin in tungsten is nearly as fatal as carbon.

What is required to solve the difficulty is a cheap and effective separator.

The Virginia-Carolina Chemical Co. reports for the year ended May 31, 1915, net earnings of $4,979,949, after deducting $1,476,126 for repairs and maintenance and setting aside $673,821 to reserve for doubtful debt. From this, interest and discount of $1,265,741 was deducted, leaving net profit for the year of $3,714,209.

Details of Practical Mining

Concrete Underground Ore Pocket at Copper Queen

By Fred M. Heidelberg*

It was the desire of the management to have the 260-ton ore pocket on the 400-ft. level of the Sacramento shaft designed with a barrel, a chute and a neck. The barrel was to contain the 260 tons of ore; the chute was to have the ore fed into it and in turn supply the ore to fill the cartridges; the neck, a necessary evil in this case, was to connect the barrel with the 400-ft. level.

The ore was to be fed into the chute from the barrel in a loose, unpacked condition. How to get the ore to feed in this condition was at first puzzling. A study was made of sand flowing through a hole in a tin can. The can was suspended about 2 in. above a table and sand was poured in. It flowed through the hole until automatically stopped by the sand-heap on the table rising to the hole. Some of the heap was then removed from beneath the can, from which the sand again flowed until stopped as before. It was evident that the sand in the can exerted very little pressure on that which had piled up on the table. It was believed that the utilization of

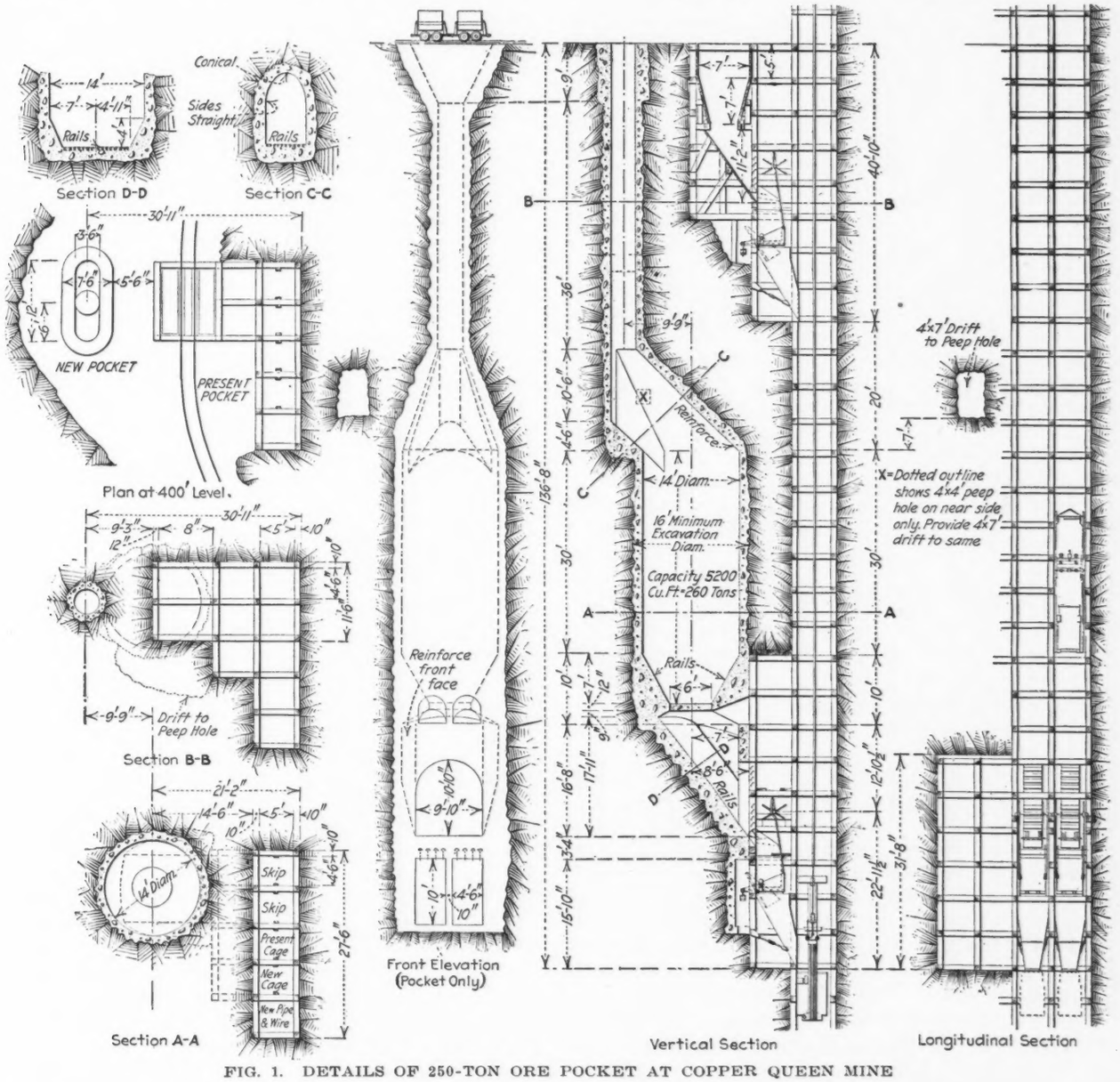


FIG. 1. DETAILS OF 250-TON ORE POCKET AT COPPER QUEEN MINE

*Box 1179, Bisbee, Ariz.

this principle would be most likely to give the results sought. The bottom of the barrel was therefore made in the shape of an inverted frustum of a cone. A diameter of 6 ft. for the opening in the frustum was decided upon as probably being best adapted to feed the ore in the manner desired and not allow it to arch in the barrel.

The long neck was provided to obviate taking out much rock around the old wooden pocket, which would have tended to weaken the pocket and the shaft. On account of the long drop from the level to the barrel, the neck was offset from the barrel so that the fall of the ore would be broken by the shelf before entering the barrel. Had the ore been allowed to fall directly into the pocket undoubtedly it would have packed and caused trouble in emptying the pocket. It will be noted that, had the proper conditions existed, the neck could have been omitted, the length of the pocket thus shortened, and the ore dumped directly into the barrel.

Keeping the ore from packing in the chute was carefully looked after. A razor-back (not shown in the design) was placed against the column in the center so as to divide the ore to the doors; 8-in. channel grizzlies were provided in the front, to allow for punching the ore should it hang up. Circular doors were called for at the end of the incline of the chute.

The cartridge- and skip-loading system, while not a part of this design, are shown. The working of the system can easily be seen from the design. The cartridge is filled and when the skip is in place the bottom of the cartridge is dropped and the ore falls into the skip.

A 4x7-ft. drift was provided from the pipe compartment to a peep hole placed just above the barrel of the pocket. This peep hole was to furnish the means of investigating the condition of the pocket when desired. A small 12x24-in. peep hole (not shown in the design) was provided where the inverted frustum and the barrel joined.

On the level where the cars dump, the neck was flared out to a funnel shape. It was made large enough to allow two cars to dump at the same time. A grizzly of 90-lb. rails, spaced 12 in. centers, was put across the funnel as a safety device.

The concrete in general was to be 1 ft. thick, reinforced where deemed necessary, and protected by 25-lb. rails where excessive wear was likely.

In constructing the pocket the design was followed faithfully except that the pocket was put on the side of the shaft opposite to that on which it is shown. The mining or excavating was done as a raise. Just as soon as enough ground had been taken out, a chute and door were put in so that the blasted rock falling down into the chute could be loaded directly into cars and hoisted to the surface. This little device saved quite a bit in the cost of excavating. Throughout, 10x10-in. timber was used. In the barrel a tower 8 ft. square was first formed, and then short stulls were put into the rock. In concreting, when the short stulls were taken out, the tower served to support the forms.

The manner of making the forms is worthy of attention. The regular 5-ft. long by 2-in. thick mine lagging was used altogether; and when the job was finished it was possible to return all but a small percentage of it to the mine for further use. From the opening in the inverted frustum to the top of the neck the lagging was nailed to 3x3x¼-in. angle-rings bent to the proper diameter. These rings and lagging constituted the forms. The inward thrust was taken up by the 8-ft. tower left in the center. The 3x3x¼-in. angle-rings had two sets of ¼-in. holes punched 1½-in. centers, staggered, with gages ¾ in. and 2½ in. This left 1½ in. between the rows of holes. For the barrel four sets of rings were used. The cycle consisted in first spiking the lagging to a ring at the bottom of the form; at the top of the lagging another ring was spiked. In this top ring the bottom row of holes was used and the end of the lagging allowed to stick up only half way between the two sets of holes, so that when the form was filled with concrete the bottom of another set of lagging could be butted on the lower forms and the top row of holes in the angle could be used to spike through. In this way 5 ft. was concreted on some days and 10 ft. on others. The same method was used in the neck. At the junction between the neck and the barrel a combination of the rings for the barrel and the neck was used with success.

The concrete was conveyed to the pocket from the surface through a 6-in. pipe, placed in the pipe compartment. From a hopper at the subway station it extended downward 400 ft., then bent and went horizontally

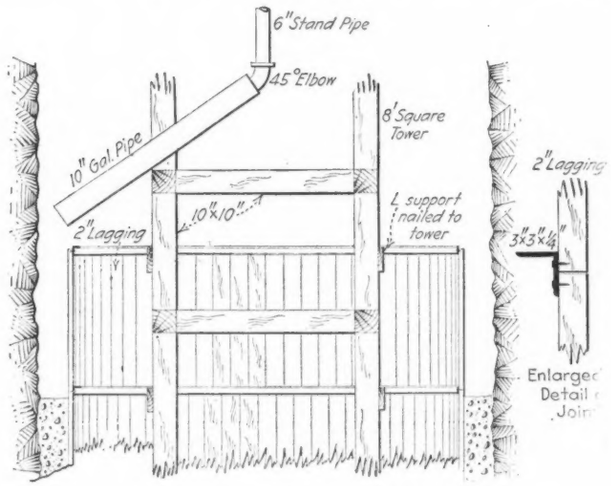


FIG. 2. DETAIL OF CONCRETING AROUND FORMS

to a hopper in the funnel of the neck of the pocket. This hopper was connected to a 6-in. pipe running down to the bottom of the pocket. On the end of the pipe was a 45-deg. elbow, over which was hung a 10-in. galvanized-iron spout which allowed the placing of the concrete wherever desired. As the concreting progressed, a length of 6-in. pipe was taken out, the 45-deg. elbow and galvanized-pipe spout fastened on and the work continued.

Since the quantity of concrete was small, no attempt was made to install a money-saving plant. The concrete was mixed with a mixer just outside the subway entrance, wheeled to the shaft and dumped into the hopper.

Fig. 2 is a section through the barrel. It shows the 8-ft. square tower, the method of using the forms, and the manner in which the concrete was placed by means of the galvanized-iron spout, which could be swung about the pipe as a center.

For dry sulphide ore the pocket worked admirably. The ore could be taken out faster than the conveying system could handle it. Although the pocket was intended for sulphide-ore storage, the management deemed it wise

to try the wet oxide ore also. This ore caused some trouble. The first time the pocket was filled the ore arched in the barrel and stuck to the concrete between the rails in the chute. The pocket was emptied, the 6-ft. hole in the inverted frustum was made 16 in. larger in diameter, and the chute was lined with boiler plate. A spray was also placed at the top of the incline of the chute so that it would keep the sheets wet. The second time the pocket was filled the ore did not arch in the barrel and its passage down the chute was quickened by the spray and the boiler plate. This pocket now works better than any other pocket in the mine handling this class of ore.

Under no circumstance is the ore taken out below the inverted frustum of the cone, for several reasons. The wear on the face of the frustum would be excessive; if the ore fell directly into the chute from such a great height, it would tend to pack there, thus defeating the original purpose of the design. As a matter of fact, through carelessness, the train attendants did fill the pocket several times up to the track on the 400-ft. level; but no trouble was experienced in emptying the pocket.

There was 361 yd. of concrete placed. The maximum progress for concreting in the barrel was 10 ft. per day, while 20 ft. was the maximum reached in the neck. The total cost of the pocket, including excavating, timbering, concreting, cartridge and loading devices, did not amount to $10,000.

Gerald Sherman, superintendent of the mine department; J. P. Hodgson, superintendent of mines, and George Mieyr, master mechanic, were active in working out the idea of the pocket, while the writer acted in the capacity of designer. Mr. Mieyr and Joe Lutz, the shaft boss, successfully carried on the construction.

Single- and Double-Hand Drilling Contests at Boulder

The Boulder County Metal Mining Association was sponsor for a successful Labor Day picnic at Boulder, Colo., participated in by both metal and coal miners. The most interesting events of the day were rock-drilling contests by hand. In the single-hand affair, Fred Dopp, of Jamestown, defended and retained his title as state champion and this despite his lack of recent practice. He drilled 17⅝ in. in solid granite in 10 min. In the double-hand contest, Dopp was paired with Roy Peterson. When it was announced, at the completion of their hole, that it was $23\frac{7}{16}$ in. deep, the spectators felt these men had won; but when the Brown brothers next took the stand and started their drilling, it became evident that something was happening. They started in with accurately timed and absolutely square blows that varied throughout the period only in their steadily increasing intensity. The Browns struck exactly one blow per second. Changes of position from striking to turning and changes of steels by the turner were made without the interruption of a single stroke. They drilled $24\frac{3}{16}$ in., Dopp and Peterson taking second place. Dopp has never been defeated in single-hand drilling, and an effort is being made to send him to San Francisco to compete for the world's championship.

Another feature of the day was a first-aid contest between drilled teams from several coal mines in this county. In this the prize, a silver cup, was taken by a team representing the Simpson mine at Lafayette. This picnic was managed by L. E. Girard, of Salina, who states that its most important result was the elimination of "an undercurrent of distrust and unfriendliness" between the men engaged in the industries of metal mining and coal mining.

Hand-Drilling Contest at Virginia City

Two contestants in a single-hand drilling contest on Labor Day at Virginia City, Nev., made the following record, the time allowed the men being 15 min. for drilling down holes: Mike Grivic drilled 32⅛ in.; William Berry, 29 in. Berry got a good start and drilled steadily, but toward the end lacked force. Grivic was the speedier and is estimated to have struck from 95 to 100 blows per minute. His third or fourth drill stuck once, but he lost very little time. George Dewar was judge of the contest. Some money changed hands on the result, but the betting was light. The purse was $100.

Mother Lode Drilling Contest

Five teams of Mother Lode miners entered a drilling contest at the union picnic of the California State Federation of Labor at Jackson, Amador County, Aug. 15. One of the teams, Voyivich and Vacilivich, of Jackson, broke one of the drills in the hole, so that their record was not available. Teams were allowed 15 min. Drilling was in Amador County granite. Payton and Dynan, of Amador City, took first prize, drilling 46½ in.; Marcus and Pedro, of Sonora, second, 46¼ in.; Zarkovich and Rupur, of Jackson, 43⅛ in.; Burbank and Kerr, of Amador City, 33¾ in.

Hand Drilling at Butte

Sam and Will Roberts drilled 37¾ in. in granite in 15 min., working as a team, at an exhibition at Lake Avuca, Butte, on Labor Day. It had been announced previously that two two-men drill teams, the contestants averaging 170 lb. each, would compete, but only one team was on hand.

Miami Hand-Drilling Contest

Double-hand drilling contests were held in Miami on Labor Day, the rock being local granite and the time the usual 15-min. period. The first prize of $250 was won by William Gholson and Jess King, who drilled 36½ in. The second prize of $100 was won by Tony Obad and Christ Palovich, who drilled 35¼ in.

Jamestown Hand-Drilling Contest

Three teams entered the rock-drilling contest at the Labor Day picnic at Jamestown, Calif. Drilling was in hard granite. Wilson and Kahl took first prize, drilling 32⅜ in. Burbank and Kerr, second, 32⅛ in. Marcus and Pedro made 31¼ in., but broke a drill and did not complete the contest. Time, 15 min.

Details of Milling and Smelting

Bradford Selective Flotation

Leslie Bradford, of Broken Hill, Australia, has patented a process of preferential flotation for the treatment of mixed sulphides, adding certain mineral salts such as thiosulphates to the water used in the flotation cells. The *Australian Statesman and Mining Standard,* of July 22, 1915, states that the distinguishing feature of the method consists in treating the ores or ore products in a medium which wets zinc sulphide and does not wet lead sulphide or pyrite and therefore leaves the last-named sulphides flotable while rendering the zinc sulphide temporarily immune to flotation. The lead sulphide and any pyrite are thus obtained first as float concentrates; thereafter the residues comprising gangue and zinc sulphide are treated for the separation of the zinc sulphide from the gangue.

This "wetting" effect, according to the patent specification, is procured by adding to an acid flotation solution a limited quantity of a substance which is decomposed by said solution, and produces in this decomposition a reducing gas which is more or less soluble in the solution. Notably thiosulphates, sulphites and bisulphites are so decomposed in a solution of sulphuric acid with the production of such a gas (sulphur dioxide). With substantially equal result, sulphur dioxide may be introduced directly into the solution, either as gas brought into it in a current or added in solution. The like effect is obtained by means of another reducing gas, sulphureted hydrogen, which may be similarly introduced into the solution or may be produced in it by adding sulphides or polysulphides which the solution is capable of decomposing.

In practice a limited quantity of such a reducing agent is introduced into the solution, prior to flotation treatment of the ore therein, with the object of procuring this zinc "wetting" effect. The reducing agents preferred by the inventor are thiosulphates, sulphites and bisulphites—as they are usually more effective than those belonging to the second group.

In the actual application of the invention to a Broken Hill mixed-sulphide ore containing zinc and lead sulphides, the flotation operation is considered in a plant of the type described in two previous Commonwealth patents, using the flotation boxes set in series, and treating ore at the rate of 25 tons per hour. No serious difficulty is experienced in correctly proportioning the sodium thiosulphate (the blende "wetting" agent) so as to insure the rapid floating off of the galena substantially pure or as a high-grade concentrate rich in silver, and to leave the residue in a condition suitable for further flotation treatment for the recovery of the zinc sulphide therefrom.

The flotation treatment is preferably conducted according to the froth-flotation principle; the procuring of the effect aimed at is dependent upon the presence of a frothing agent in the flotation medium, only when a reducing gas is introduced into the medium; it is not dependent upon the presence of a frothing agent in the flotation medium when a reducing gas is generated in the flotation medium by reaction of a substance introduced into it. In some cases enhanced results are obtained by digesting the ore with sulphuric acid and the reducing agent in a thick pulp, prior to subjecting the same to a flotation operation.

Chart for Determining Plies of Conveyor Belts

The accompanying chart,[1] drawn by J. D. Mooney and G. L. Darnell, of the B. F. Goodrich Co., Akron, Ohio, offers the means of quickly determining the correct number of plies for conveyor belts operating under various conditions. The calculations are based on the average safe strength (factor of safety, 15) of various standard rubber conveyor belts, and assume maximum loading conditions; that is, the belt is considered as carrying the greatest load it will handle without spillage at ordinary belt speeds. This not only produces the most economical operating condition, but also the maximum tension in the belt. The chart is a graphical representation of the formula:

$$p = k\,g\,W\,(L + 10\,H)$$

where

p = Correct number of plies;
k = A constant depending on the type of drive;
g = Weight in pounds per cubic foot of material handled;
W = Width of the belt in inches;
L = Length of the belt in feet (approximately twice the center distance);
H = Difference in elevation between the head and the tail pulleys in feet.

For a simple drive with a bare pulley, k equals $\frac{1}{250,000}$. For a simple drive with a rubber-lagged pulley, k equals $\frac{1}{300,000}$. For a tandem drive with bare pulleys, k equals $\frac{1}{375,000}$. For a tandem drive with rubber-lagged pulleys, k equals $\frac{1}{455,000}$.

The chart is drawn for a simple drive with the bare pulley $\left(k = \frac{1}{250,000}\right)$; therefore the number of plies obtained from the chart should be multiplied by the factor 0.83 or $\frac{5}{6}$ for simple, lagged drive; the factor 0.67 or $\frac{2}{3}$ for tandem, bare; and the factor 0.55 or $\frac{11}{20}$ for tandem, lagged drive.

To find the correct number of plies for a conveyor belt, knowing the width, the length, the difference in elevation between the head and the tail end and the kind of mate-

[1] "Bull. of A. I. M. E.," September, 1915.

rial to be handled, proceed as follows: Start with the width given at the top of the chart and move down until this line intersects the line corresponding to the proper length factor ($L + 10\ H$); then move either right or left until the line corresponding to the given material is met; then move down again to the scale of plies where the next largest figure will give the correct number of plies.

For example: To find the correct number of plies for a conveyor belt 36 in. wide and 300 ft. long, with 20 ft. difference in elevation, handling sand and gravel—follow the line from the 36-in. width downward until it intersects the 500 length-factor line; then follow to the right until the sand-and-gravel line is intersected; then down to the ply scale, where the ply will be found to be 7.

The formula $p = k\ g\ W\ (L + 10\ H)$ has been developed mathematically from the following formulas

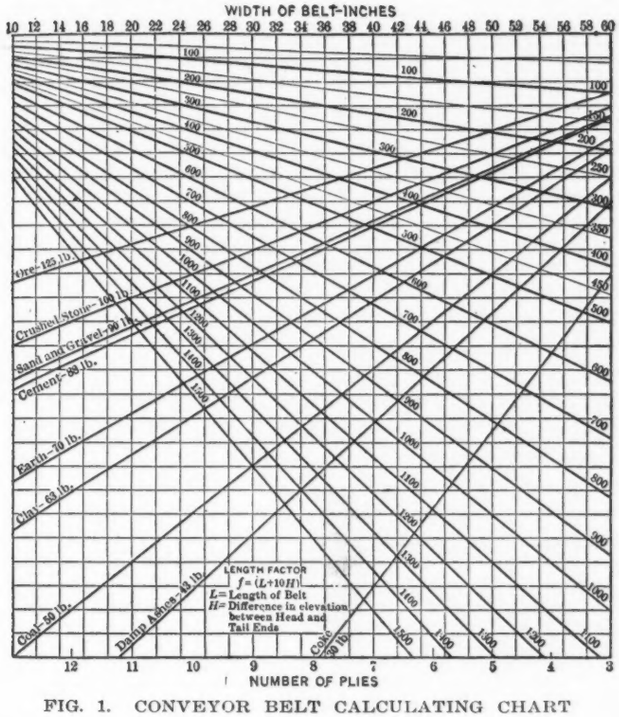

WIDTH OF BELT-INCHES
10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60
Ore-125 lb.
Crushed Stone-100 lb.
Sand and Gravel-90 lb.
Cement-80 lb.
Earth-70 lb.
Clay-60 lb.
Coal-50 lb.
Damp Ashes-45 lb.
Coke-30 lb.
LENGTH FACTOR
f = (L+10H)
L= Length of Belt
H= Difference in elevation between Head and Tail Ends
12 11 10 9 8 7 6 5 4 3
NUMBER OF PLIES

FIG. 1. CONVEYOR BELT CALCULATING CHART

which have been found to work satisfactorily in average practice:

$$U = \frac{0.08\ W^2 S g}{5{,}000} \qquad HP = \left(\frac{0.02\ l}{100} + \frac{0.01\ H}{10}\right) U$$

$$T = \frac{C \times HP \times 100}{S} \qquad p = \frac{T}{24\ W}$$

where

U = Capacity in tons per hour;
W = Width of belt in inches;
S = Belt speed in feet per minute;
g = Weight per cubic foot of material handled;
HP = Horsepower developed in driving conveyor belt;
l = Length of conveyor in feet (approximately one-half L);
H = Difference in elevation between the head and tail pulleys in feet;
T = Total tension in the belt in pounds;
p = Correct number of plies; C = The constant of the drive.

For a simple-drive, bare pulley, $C = 600$. For a simple-drive, rubber-lagged pulley, $C = 500$; for a tandem-drive, bare pulleys, $C = 400$; for a tandem-drive, rubber-lagged pulleys, $C = 330$. The length factor f equals $L + 10\ H$, represented on the chart by the lines 500, 600, 700, etc., is a developed factor equal to the sum of the length of the belt and 10 times the difference in elevation between the head and tail pulleys.

Hall Smelting Process to Eliminate Sulphur Dioxide

William A. Hall, of New York, has been granted a patent (U. S. pat. 1,133,637) for a process to prevent the escape of noxious gases in smelting, particularly of SO_2 commonly produced in the focus of the blast furnace. This is accomplished by maintaining at the top of the charge a temperature below that at which free sulphur will ignite and by spraying the top of the charge with a liquid containing water, thereby producing sufficient hydrogen sulphide to reduce the sulphur dioxide in the furnace gases. Spray pipes are placed in the furnace stack, and as the water percolates downward it keeps the top layer of the ore much cooler than in ordinary smelting of sulphide ores. When the water has reached a point where the temperature is high enough to convert it into steam, the latter reacts with a certain amount of sulphide ore and the evolution of H_2S results. This combines with the SO_2 to form water and elemental sulphur, the latter passing upward in the form of vapor and being condensed in the dust chambers. The reaction may not be completed in the furnace stack, but may proceed in the fume-settling system. A high-ore column and the exclusion of false air in the upper part of the stack are recommended.

Rapid Test for Fineness of Paint Pigments

The Multi-Metal Separating Screen Co., of New York, has succeeded in making 350-mesh screens (122,500 apertures per sq.in.) of vanadium-bronze wire about 0.001 in. diam., with which different operators, using different screens, can obtain concordant results, according to C. D. Holley and J. C. Brier, *Oil, Paint and Drug Reporter,* May 10, 1915; abstr. *Journ. Soc. Chem. Ind.,* June 15, 1915. These screens have proved of value for testing the fineness of pigments. The particles passing through can be ground economically in a paint mill, but those retained on the screen, even when present in relatively small amounts, rapidly reduce the efficiency of the mill. The sample (25 grams) is washed through the screen by means of water, using a soft brush to break up lumps. Calcium and manganese oxides, as used by varnish manufacturers, can be tested in a similar manner, using naphtha instead of water. The results obtained with consignments of various commercial pigments varied greatly in many cases from those yielded by the small sample used as a basis of purchase.

E. Langguth States in a Patent Specification (German, 282,131, Oct. 8, 1913) that when mixed sulphide ores are being treated by the oil flotation process, a solution of zinc chloride acidified by chlorhydric acid, added after the oil, causes the sulphides of zinc and lead to sink while other ores float.

American Institute of Metals

The first technical sessions of the Allied Foundrymen's Organizations were held at Atlantic City, N. J., on Tuesday, Sept. 28. The headquarters of the meeting was at the Traymore Hotel.

A joint opening session of the American Institute of Metals and the American Foundrymen's Association was held in the morning, the papers relating exclusively to foundry practice. In the afternoon the American Foundrymen's Association held a session on Young's Pier, while the American Institute of Metals held a technical meeting at the Traymore. At the latter, the first paper presented, "An Investigation of Fusible Tin Boiler Plugs," by G. R. Burgess and P. D. Merica, was discussed by the latter, who gave some supplementary data. He said that in the case of some boiler plugs which had been overheated, but did not blow out, investigation showed that the metallic tin had been partly transformed into the oxide, the latter having a melting point of about 1,600° C. against 320° C. for pure tin. Oxidation began on the water side of the plug and progressed in the form of a complicated network of fine veinlets, utterly destroying the utility of the plug.

It was also shown that a small percentage of zinc in the tin destroyed its value as a safety plug by changing the melting point. Analysis of various plugs showed that many contained from 0.3% to 4% Zn, while pure Banca tin should not contain more than 0.01% to 0.03% Zn.

The next paper was on "The Influence of the Impurities of Spelter on the Cracking of Slush Castings," read by the author, Gilbert Rigg, of the New Jersey Zinc Co. This paper elicited considerable discussion. The fact was brought out that even small quantities of impurities, among which cadmium was prominently mentioned, tended to produce cracking, often microscopic, which lowered the value of the castings. Incidentally it was brought out that the reasons are the same which have made it necessary to use highest-grade spelter for making brass to be utilized in munitions of war. Small proportions of iron harden the brass, while cadmium has a general deteriorating effect, although the speakers could not definitely name its activities.

The two papers announced to follow—"Cobalt in Nonferrous Metals" and "Furnace Methods for Pure Castings"—were not presented, their preparation having been interferred with.

Doctor Rawdon's paper on "Standard Test Specimen of Zinc Bronze" was read and explained by Dr. G. K. Burgess. The 88:10:2 mixture was discussed at length. One of the points brought out was in response to a question asked as to whether the bad effects of oxidation in this mixture were due to furnace practice or to pouring practice; if the former, a remedy might be found in the electric furnace with its reducing atmosphere. Doctor Burgess was of the opinion that furnace practice was largely responsible.

As to deoxidizing agents, phosphorus, manganese and barium were recommended as the most promising. Little was to be expected from calcium or silicon, since their use introduced features antagonistic to good results.

Doctor Hoyt's paper on copper-rich kalchoids was presented by the secretary, but provoked no discussion. The members attended a theater party in the evening. G. H. Clamer presided at these sessions, W. M. Corse, secretary.

British Mineral Production

The mineral production of Great Britain from mines coming under the Coal Mines and Metalliferous Mines acts was given in the *Journal* for July 3, p. 6. The statement is now completed, the British Government having just issued the statistics covering the production from workings under the Quarries act, which covers all quarries and openpit workings.

Quarry-Production Quantities

The production from these workings in 1914 included 2,342 tons bog ore; 100 tons chromite; 21,363 tons coal; 39 tons copper ore; 9,128 tons fluorspar; 45,269 tons gypsum; 5,761,336 tons iron ore; 25 tons lead ore; 11,845,236 tons limestone; 1,450 tons dressed tin ore.

The most important item of quarry production was iron ore. The total ore mined in Great Britain in 1914 was: Coal mines, 7,241,481; metal mines, 1,743,011; quarries, 5,761,336; total, 14,745,828 long tons, which is a decrease of 1,251,500 tons from 1913. The small quantity of coal from open workings makes the total production of Great Britain 265,664,393 tons in 1914; a total decrease of 21,766,080 tons from the preceding year.

Number of Employees and Accidents

The total number of persons employed at quarries and open works under the Quarries act was 78,908, of whom 50,074 worked inside the actual pits or excavations, and 28,834 outside. Compared with 1913 there is a decrease of 1,192 inside workers, and of 809 outside workers, making a total decrease of 2,001 in the number of persons employed at quarries. The persons employed occasionally at quarries are not included in the above figures.

There were 95 persons killed, or 1.20 per 1,000 employed; the rate for inside workers being 1.54 and for outside 0.62 per 1,000. As compared with 1913 there was an increase of 10 persons killed, but a decrease of 576 in the number injured.

Molybdenite Production in New South Wales

A report on the probable output of molybdenite in New South Wales made by Arthur D. Pedley for the government gives the following estimate:

There are several works for the treatment of molybdenite in Sydney, and several of the mines treat their product in the country.

As to production, there was a letter in the London "Times" on, I think, Apr. 6, stating that the production of molybdenite from that date to June 30 next would be 100 tons. Whoever wrote that letter must have known such would not be the case. It would be impossible. When the statistics are available, it will be found that instead of 100 tons the amount will prove about 40 tons—and perhaps a little under.

As to the future export—say from July to December inclusive—I think it will prove about 60 tons. Any sensational increase or decrease is not to be expected. More than half the amount quoted will come from old dumps that have been left lying on the surface for years; the other half will come from mines now working.

A good many molybdenite mines are now coming to light, but the statements as to their value are inflated. It will require more than present prices to make them pay in most instances.

The ore is found in pipes and not in lodes or reefs; in consequence, a mine may last for a year or two or the pipe may come to an end in a week's time without any previous indication, and thus it is a precarious industry.

Correspondence and Discussion

Mining-Stock Brokers

The editorial on "Mining-Stock Brokers" in the *Journal* of Sept. 4, 1915, not only does an injustice to most of the brokers of the Salt Lake Stock and Mining Exchange, but also states as facts reports which the editors have of course read or received from their correspondents, but concerning which they have been somewhat misinformed.

The brokers of the Salt Lake City Exchange did not "suspend a regular session in order to congregate in the so-called Gold Room of the Commercial Club in order to do honor to a notorious exponent of the black art who was warmly welcomed and feasted" because he was "going to foster a boom in the Alta stocks," nor did they suspend any session, nor extend any official notice of his presence. A luncheon was given for him to which some of the brokers were invited, and when the time arrived for the opening of the exchange one of the members of the exchange proposed that the time of the second call, which usually begins at 1:30 p.m., be postponed until the luncheon was over, and it was postponed for those present. A dinner was also given for him here by some of his business associates and a number of the brokers were invited, but only a small percentage of the members of the exchange attended, and they were well outnumbered by the business men of the city. The editorial written at the time concerning the dinner was certainly approved by a large majority of the members of the Salt Lake Stock and Mining Exchange to whom I showed the article.

This "Alta boom" was not fostered nor matured here but in the city of New York. Practically all the Salt Lake brokers warned their clients of its danger, and those who had Eastern connections warned them as well.

The *Journal* speaks of our Utah Copper Co. in a complimentary way in its editorial and the legitimate speculation in its shares. Every producing mine in Utah which was financed here is, I believe, listed on the Salt Lake Mining Exchange. They were not invited to list their shares, but an application had to be made by each company with a statement showing who the officers were, what the financial condition of the company was at the time of listing, and a fee of $100 was paid by each company upon the acceptance of its application. Surely if the Salt Lake Exchange were "cheap and contemptible," as the *Journal* leads one to infer when it states that nearly all the interior exchanges are, then such men as manage the Silver King Coalition, the Daly Judge Mining Co., the Silver King Consolidated Mining Co., the May Day Mining Co., the Eagle and Blue Bell Mining Co. and many others equally well managed would withdraw their listing from the Exchange. It is not generally known, but is a fact, that the Salt Lake Exchange was one of the very few in the world that did not have to close its doors a year ago.

It will be found on investigation that not only did the majority of the Salt Lake brokers oppose the late "Alta boom" but also that the public of Salt Lake used the opportunity to liquidate practically all their holdings in the manipulated stocks.

I have read the *Journal* many years and know that it would not knowingly misrepresent any circumstances for any purpose. I trust therefore that it will at least correct the misstatements contained in its editorial, even though it is considered that the general tone of the editorial is warranted.

JAMES A. HOGLE.

Salt Lake City, Utah, Sept. 18, 1915.

Cost of Winter Construction

In the *Journal* of Aug. 28 I have noticed an article entitled "Cost of Mill Construction," by Harry T. Curran. Any description of methods of using concrete is interesting to me, but I must take exception to some of the recommendations which Mr. Curran makes in that portion of his article under the heading, "Difficulties of Winter Construction."

While I realize, of course, that the increased cost of concrete work done in cold weather may range within wide limits, I question whether the statement that such increased cost will easily reach 50% over costs under favorable conditions is true. In fact, where such results follow, I question whether the conditions would be such as to warrant undertaking the construction, from the standpoint of safety as well as other standpoints.

Furthermore, I question the statement that "after 12 hr., freezing can only retard the final set but cannot injure the concrete," especially in view of the fact that later on in Mr. Curran's discussion he advocates the use of integral salts, either calcium or sodium chloride, to lower the freezing point of concrete.

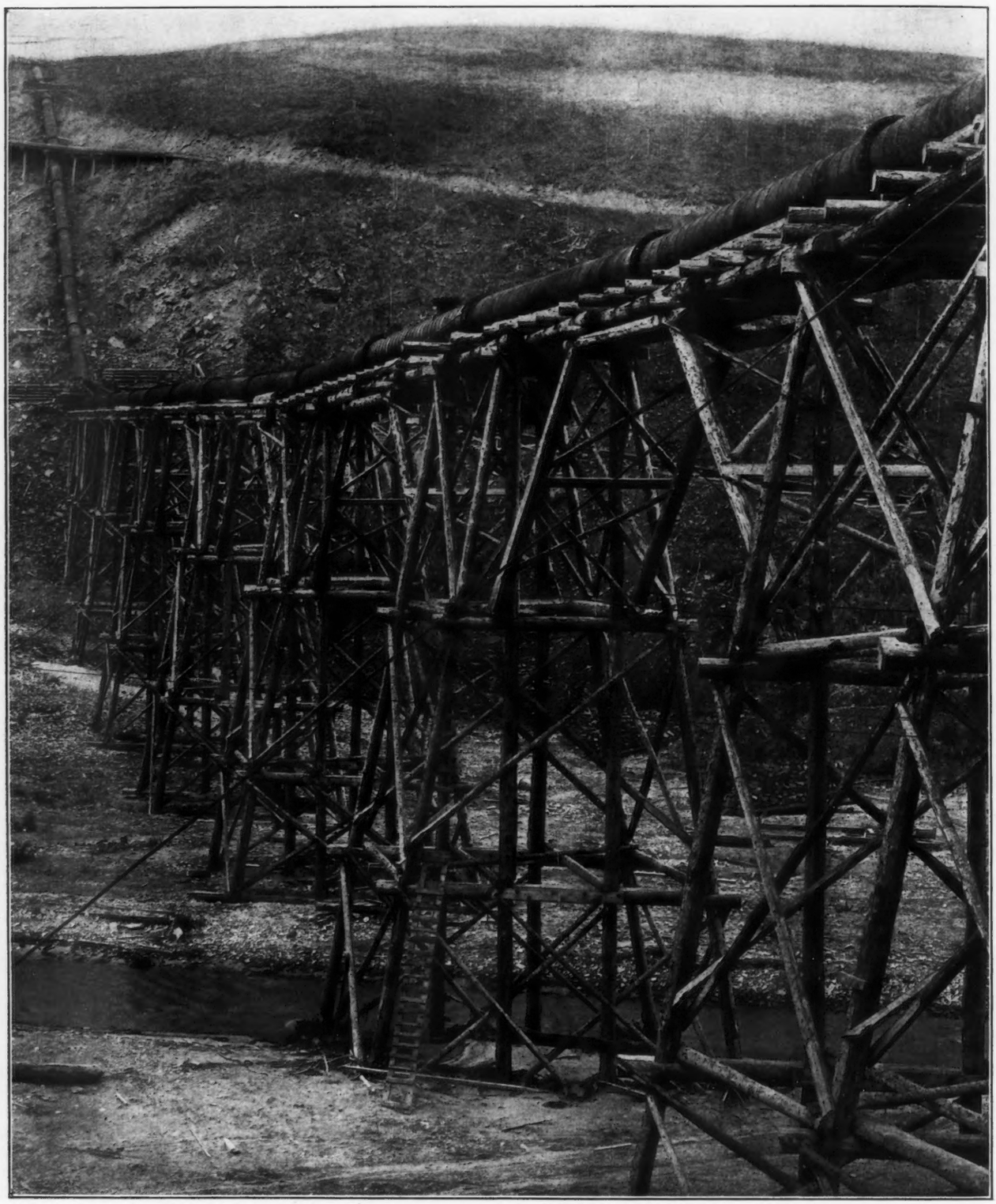
All experience in concrete construction in winter points to the desirability of heating aggregates and mixing water, and so effectively protecting freshly deposited concrete that early hardening will be hastened as much as possible under favorable conditions, which means in the presence of heat and moisture. Adding integral salts defeats these desirable ends. Furthermore, if any portion of the construction is eventually to be exposed to view, there will develop in the course of time more or less unpleasing efflorescence.

In view of the fact that cold weather is approaching and it will be necessary, perhaps, to complete some unfinished concrete work under less favorable conditions than when such work was started, I believe it is well to call attention to methods that have proved best and to emphasize these methods rather than confuse the worker with a lot of possibilities, some of which had much better be avoided, when it is generally such an easy matter to arrange for heating the materials and doing the work in the best way.

H. COLIN CAMPBELL.

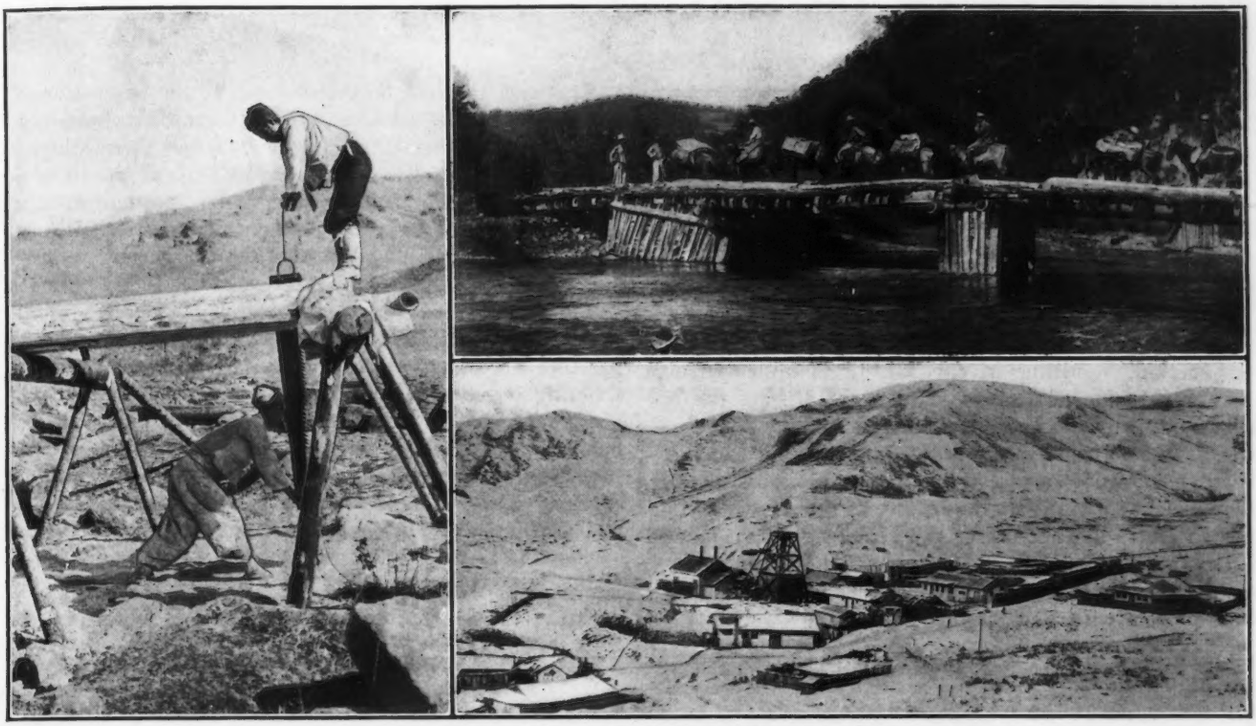
Chicago, Sept. 4, 1915.

Photographs from the Field



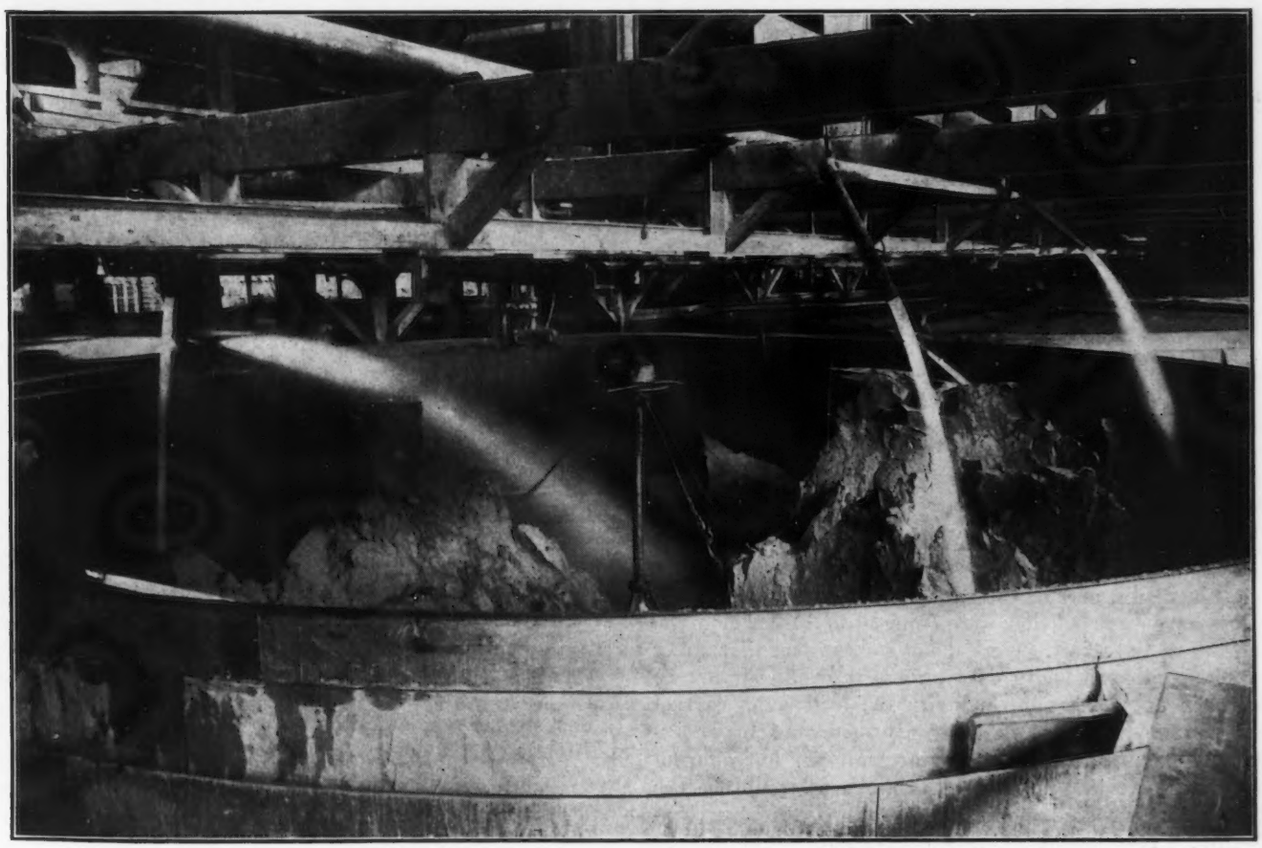
YUKON GOLD CO.'S PIPE LINE CROSSING A VALLEY

Trestle carrying the line over Bonanza Creek, bringing water under pressure for the hydraulic workings. Spiral riveted pipe, 49 in. in diameter, with a maximum head of 1,100 ft.



KAPSAN COPPER MINES OF COLLBRAN-BOSTWICK DEVELOPMENT CO., CHOSEN

At the left is shown the Korean method of sawing mine timbers. At the right, above, is the mine-supply train crossing a native bridge, and below is shown the company's mine and office building



DISCHARGING A SAND TANK BY SLUICING AT THE HOMESTAKE MILL, LEAD, S. D.

Timbering in the New York Subway

By Percy E. Barbour*

SYNOPSIS—An analysis of conditions that brought about the recent subway disasters in New York City, which resulted in a tie-up of many car lines and much street traffic and in considerable loss of life, and how the accidents could have been avoided by proper mine timbering.

During the last four days of the past week there were two serious accidents in the New York subways under construction, resulting in the killing of nine persons and the injuring of a great many more, besides the tying up of many blocks of New York's already congested streets. These subways are being constructed with as little interference to surface traffic as possible. This is accomplished by digging up the surface of the streets, laying heavy timbers and on top of these placing heavy planking, and then, in effect, stoping out the ground underneath these timbers and catching them up on vertical bents or sets with long vertical legs. These excavations vary in depth, and in the two sections where these accidents have occurred they were from 30 to 36 ft. below the surface of the street. Were it not for the fact that street traffic is allowed above excavations, it would simply be an opencut proposition, but with the load being carried on the timbers above it is strictly analogous to underground stoping, with the hanging wall flat but offering very little weight, not nearly so much as would be the case in any ordinary mining operation requiring timbering. The height of this excavation would not be greater than an ordinary four- or five-set stope.

FIG. 1. CAVE AT CORNER OF BROADWAY AND 38TH ST. AND STEEP WESTERLY DIP OF SCHIST

The first accident occurred Sept. 22 on Seventh Ave. between 24th and 25th St. It was caused by shooting a round of four holes, "one 10-ft. hole and three others," which was done by electric battery. Some of the timbers were shot out, and the entire supporting structure for a distance of about 300 ft. went down like a row of dominoes, carrying with it a loaded street car, several vehicles and many pedestrians.

The rock being blasted is a hard but brittle rock which breaks short and, being traversed by joint planes, close together—breaks "blocky," as a miner would say. The shooting out of a timber or a set of timbers is a forgivable thing, either in a mine or a New York subway, but if a light blast such as was used in this subway work resulted in the destruction of an entire stope, the mining engineer would not consider the matter excusable.

The *Engineering News* in describing the accident says:

There is no longitudinal diagonal bracing in either upper or lower tier of posts. Although the posts—considering the whole height from floor to street—are virtually jointed in the middle by the interposition of the 24-in. I-beams (with flanges 7 in. wide), the framework is held firm under normal conditions by its continuous connection to some abutment at the extreme forward and rear ends of the work.

As a precautionary measure since the collapse, longitudinal diagonals have been bolted to the lower tier of posts at intervals in the remaining timbering of this contract section.

The second accident occurred Sept. 25 at the corner of Broadway and 38th St., when a fall of rock from the western wall of the excavation wrecked some of the timber supports and caused the collapse of the supporting structure and the sinking of the street for its entire width and for a distance of 70 ft. along Broadway.

One pedestrian was killed and several were seriously injured. The point of collapse is directly in front of a

*Mining engineer, editorial staff of the "Engineering and Mining Journal."

theater, and four or five other theaters are within a radius of 300 ft. Had the collapse occurred half an hour later the results would have been more serious.

Method of Timbering Used

Fig. 2 shows a cross-section looking north, taken just south of where the cave occurred. The original timbering is shown in full lines and the dotted lines represent the timbers which have been added for safety since the cave-in. The rock at this point is Manhattan schist, dipping in a westerly direction about 60 deg., as can be plainly seen in the illustration (Fig. 1). On the east side, or right-hand portion of the cut, this schist slabbed off to such an extent and so frequently and caused such inconvenience and danger that dowel pins were put in the rock, being long iron bars driven into drill holes and grouted in with cement. These were supposed to pin the slabs to one another and to solid rock beneath.

These pins did not prove fully efficacious and blocking was later resorted to. Almost the entire length of the east side of this excavation shows that a large amount of this slabby material has had to be removed, either before it fell into the cut or afterward, and there is a large opening generally at the top of the timbering along this east side. The work done here and the precautions taken indicate that the slabby nature of this ground was perfectly well known. On the west side of this excavation the schist of course is "dipping into the ground." One of the engineers in describing it said that "on this side it dipped the wrong way," and his tone implied a helpless, grieved feeling because the problem presented was not as easily solved as that on the right side.

Explanation of Fall of Rock

In discussing bedding, schistosity and cleavage, Spurr* says:

"When any rock, but particularly a shale, is exposed to pressure by the movements of the earth's crust it is apt to break easily into sheets along certain planes determined by the direction of the applied forces. These planes are called cleavage planes. They may lie at any angle to the bedding planes, or may even coincide; they may be straight while the bedding planes are folded; in short, the two sets of parting planes have no relation to one another.

"A rock may not split at all along its true bedding planes, while it may separate perfectly along cleavage planes which run across the stratification; but the cleavage must not for that reason be mistaken for bedding."

Therein lies the explanation of the rock slide so variously attributed by different investigators to "soft pockets," "unknown seams," "rotten rock" and other mysterious causes. The west side of the excavation being insufficiently timbered, the schist slabbed off in blocks determined by these planes. The planes are not lines of dangerous weakness when the opening is adequately timbered. They are so common in mining that no special consideration is given them, except to timber such blocky ground properly.

The timbering, as shown in Fig. 2, was put in at intervals of 10 ft. The posts were very infrequently and insecurely blocked against the ground and no lagging whatever was used.

*"Geology Applied to Mining," pages 32 and 33.

It is an axiom of mine timbering to prevent the rock in place from moving, not to hold it after it has started to move, because then an easy problem becomes difficult.

It is evident from looking at the sketch that this timbering was not put in with any idea of following mining methods. As originally placed these bents had no transverse or longitudinal bracing, with the exception of the member marked *A*. Just why this member was put in the original scheme is not apparent.

The diagonal added at *B* since the accident happened is of practically no use, but the diagonal at *C*, of which three were put in, in the three bays immediately south of the cave, is a good "stull" and its use recognizes the fact that the rock on the west side needs and can be supported. The timbering at *E* is of more than doubtful value, even as a precautionary measure. The longitudinal bracing at *D* was placed after the accident, to prevent any likelihood of these bents "dominoing" as did those in the Seventh Ave. section.

The timbering was put in for either or both of two reasons—to support the street load above or to support the side walls and preventing their caving. If put in for the former reason alone, there was grave fault in not providing for the second; and if put in with any thought of the

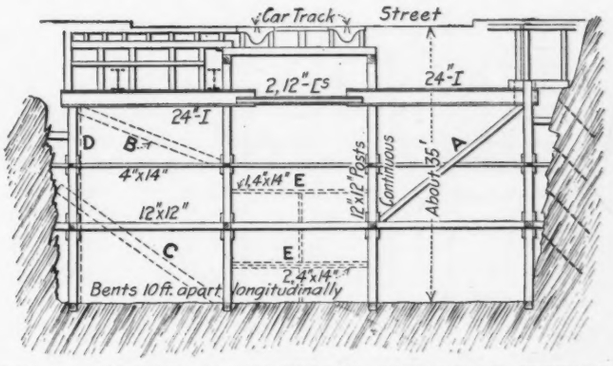


FIG. 2. SKETCH OF TIMBERING BROADWAY SUBWAY SOUTH OF 38TH ST.

second purpose, the inadequacy of the timbering for that purpose is, to a mining man, manifestly evident.

In Fig. 3 is shown the method of square-set timbering developed on the Comstock lode more than 40 years ago, which has been widely used throughout the mining world ever since. This method is used in all kinds of ground, heavy or otherwise, and regardless of the dip of the strata. In square-set timbering, in ground which presents any difficulties, kneebraces or diagonals are commonly used. It is not usual to have the greatest dimensions of any set more than 8 ft.

The timbering as shown in Fig. 2 cannot be said to approach square-set timbering in any way, but it does indicate that square-set timbering could have been used without any inconvenience to subsequent construction—in the way of putting in concrete piers or erecting the steelwork for the permanent structure. This would have afforded complete security against the fall of rock which caused the second accident and would have prevented the collapse of the entire structure if it had been used at the scene of the first accident.

Thus two serious accidents causing much damage and loss of life have occurred through overlooking the precautions taken by the miner in his every-day work when confronted by similar problems.

A special committee has been appointed to investigate subway conditions. An effort was made to reach D. C. Jackling, failing which John Hays Hammond was invited to serve, but declined, suggesting B. B. Thayer,

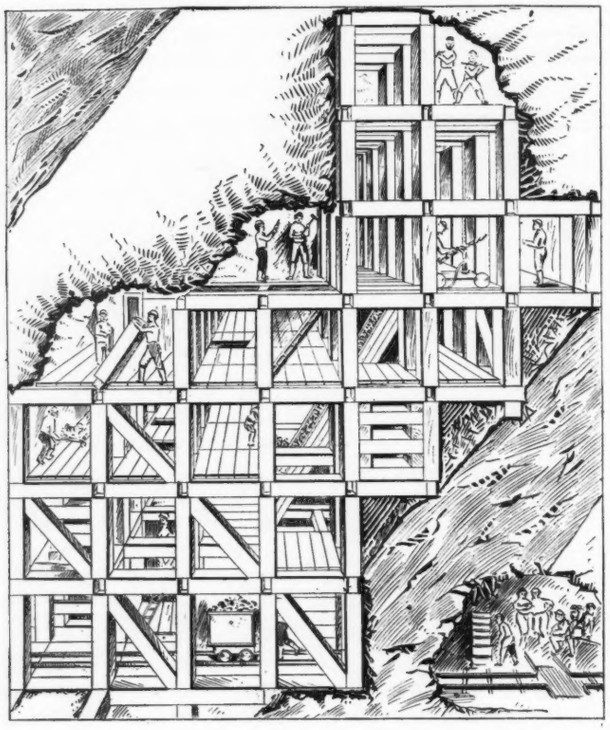


FIG. 3. AN EXAMPLE OF SQUARE-SET TIMBERING

of the Anaconda. A wise but belated move on the part of the Public Service Commission, this consulting the mining engineer.

Forfeiture of Co-Owner's Interest in Claim

By A. L. H. Street*

The Federal statutes relating to the forfeiture of a mining claim on failure of claimant to perform labor or make improvements to the value of at least $100 annually, until patent has been issued, provide that upon failure of any one of several coöwners to contribute his proportion of such expenditures, the coöwners who have performed the labor or made the improvements may, at the expiration of the year, give the delinquent coöwner personal notice in writing or notice by publication at least once a week for 90 days in the newspaper published nearest the claim. If, at the expiration of 90 days after such notice, the delinquent fails to contribute his proportion of the expenditure, his interest becomes the property of his coöwners who have made the required expenditures.

This provision has just been applied by the United States Circuit Court of Appeals, Ninth Circuit, in the case of Thompson vs. Pack, 223 Federal Reporter, 635. The parties were coöwners of 175 mining claims, upon which, under the law, $17,500 assessment work was required annually. Defendant served notice that for two years he had expended $5,600 for labor and improvements, and this notice was asserted as the basis for forfeiting plaintiff's interest. In deciding that the notice was insufficient, the Circuit Court of Appeals says:

> The only labor or improvement required by the statute which will entitle a coöwner doing the work or making the improvement to forfeiture from a delinquent coöwner of his interest is the expenditure of the full sum required by the statute, namely, not less than $100 for each claim. In order that the interest of a delinquent coöwner may be forfeited, it is essential that the entire work shall be performed by one or more of the coöwners claiming the forfeiture. . . . The notice did not claim that the entire work required by the statute had been performed for the years 1911 and 1912. On the contrary, it conclusively appears from the notice that only a small proportion of the work required had been performed, and if the amount stated in the notice was all the work that had been performed on all the claims, and it is so stated in the notice, they were then all subject to relocation, and no interest was saved by a partial compliance with the statute. The notice being insufficient on its face to entitle the defendant to claim a forfeiture of the plaintiff's interest in the mining claims mentioned therein, and this also appearing by direct and positive allegations of the complaint, the court below was right in issuing its temporary injunction suspending defendant's forfeiture proceedings until the actual facts can be ascertained and the questions involved determined upon the merits.

*Attorney, St. Paul, Minn.

Imports and Exports of Metals

Advance reports from the Department of Commerce just issued give the imports and exports of the principal metals in detail for the month of July. These are of especial interest at the present time.

Imports and exports of copper in July are given as follows, in pounds:

	Imports	Exports
Ore and matte, contents	11,302,587	339,342
Unrefined, bars, etc	17,742,587	200,071
Refined, bars, plates, wire, etc	4,253,889	46,561,376
Scrap and clippings	991,950	106,355
Totals	34,291,013	47,207,144

For the seven months ended July 31 the total imports of copper were 73,944 long tons; exports, 177,842 tons.

Imports of lead in all forms in July were, in pounds:

Lead contents of ores	2,024,488
Lead in bullion and base bullion	5,057,234
Lead, metallic	9,375
Total	7,091,097

Of the total imports 6,719,991 lb. came from Mexico and 248,315 lb. from Canada. For the seven months ended July 31 the total imports of lead reported were 34,692 short tons.

Imports and exports of zinc in July are reported below, the figure being in pounds:

Imports	
Zinc contents of ore	9,813,820
Zinc, metallic	119,593
Total imports	9,933,413
Exports	
Pigs, bars, plates, etc	15,914,602
Zinc dross	791,175
Zinc dust, re-exports	22,400

Of the metallic zinc, 3,752,248 lb. is reported as produced from foreign ores. The tonnage of ore imported was: Canada, 324; Mexico, 3,353; Japan, 1,011; Australia, 5,808; total, 10,496 tons. The total exports of metallic zinc for the seven months ended July 31 were 77,976 short tons.

Aluminum Manufacture in Russia is said to be probable. The British Aluminium Co. has secured control of some large bauxite deposits in that country, and plans are being prepared for a plant. The location is uncertain as yet, but it will be in the brown-coal district of South Russia, or near the Imitra Falls, where a large waterpower can be utilized.

Editorials

Subway Cavings in New York

The caving of portions of the subway under construction in New York has been locally the absorbing theme of the day. The municipal authorities, the Public Service Commission and the public generally have given a disagreeable exhibition of loss of both nerve and common sense. The redeeming feature has been the soberness and good judgment of the better class of the daily papers.

In the first cave, Sept. 22, many persons passing upon the street dropped into the hole when the street fell from under them and several were killed. The second cave occurred Sept. 25, about half a mile from the first, and one of the persons who fell in with the street was killed. It is significant that both of these accidents occurred in portions of the subway that are being built by one contractor.

There is no use in going into hysterics over these particular accidents. In the construction of any big piece of work—a skyscraper, a subway or a canal—there is inevitably a certain toll of human life. It is part of the expense. The subway construction in New York—a work performed under singular difficulties—has been on the whole remarkably free from disasters. This is no excuse, however, for accidents outside of the ordinary ones that are bound to happen in doing any work. The most unfortunate thing about the recent events was that the fatalities were of citizens walking the streets, where they had a right to be, not of men engaged in the work, who might be more or less responsible for what befell them.

The subway construction in New York is being done by what is called the "cover-and-cut" system; that is, the street is planked over and the earth and rock are undercut, the planking being supported by beams and posts in order that street traffic may proceed as the subterranean work goes on. The process is therefore analogous to many operations in mining.

An investigation of the places of the recent disasters by the *Journal* has convinced it, however, that no such methods of supporting the ground were in use as would be in ordinary mining practice. The problems confronting the subway engineers were no different from what the mining engineer has to meet all the time. Indeed they were of very ordinary character. The technical points are described and discussed elsewhere in this issue.

Summarizing, any mining engineer would pronounce the recent subway caves to be due in one case to "'shooting out timbers" and in the other to "run of ground," both resulting in disasters owing to "bad timbering." In the case of the second accident, the subway trench was being cut through mica schist—not an especially treacherous rock—the sheeting of the schist passing diagonally through the trench. As the trench was excavated the schist had the natural tendency to slide off on one side and slab off and fall on the other side. This was recognized by the subway engineers, who tried to prevent the slides on one side by drilling holes into the rock and driving in steel bars—"lewie" pins, they called them—spiking down the rock, so to speak. On the other side (which was where the cave occurred) they did not apparently know what to do. The proper safeguard here—and on the other side as well—was adequate timbering.

The timbering that was done in these portions of the subway—in other portions there is similar work—was manifestly designed mainly with a view to holding up the roof. For holding back the rock at the sides there was neither timber enough nor was it properly placed, the imperfection of placing being more important, however, than the deficiency of quantity. A mining engineer often accidentally shoots out a portion of his timbering or experiences a run of ground, but when either of those things happens he does not lose a whole stope and let the upper floor come tumbling down upon him.

As well as we can make out, the engineers of the Public Service Commission have left the matter of supporting the ground to the engineers of the contractors. All of them have manifestly proceeded on the theory that they were doing nothing more serious than digging a sewer. The services of mining engineers seem neither to have been solicited nor wanted. After the occurrence of these accidents, however, the Public Service Commission, in inviting a committee of three distinguished engineers to investigate and report, thought of having a mining engineer for one of the three. It probably would be better if they had thought of having mining engineers in a larger proportion, say two out of three, or three out of three.

If any blame is to be fixed for the two cave-ins, the *Journal* is of the opinion that it should fall upon the responsible heads of the Public Service Commission for not obtaining the assistance of some mining engineers when the subway work was begun. The engineers in actual charge of the work found themselves against problems for which they had no previous experience and simply did not know how to meet. In other portions of the subway there may be stretches of ground that also are treacherous and there may be stretches that would be safe without any timbering. The whole thing ought to be looked over by some mining engineers who are experts in timbering, not merely by mining engineers, for there are a lot of them who do not know anything about timbering. In the meanwhile it is ridiculous for Mayor Mitchel to be giving directions for more braces and having his orders carried out by somebody *spiking* on a few 3x10-in. diagonals with *four 60-penny nails* per end.

The Public Service Commission thought to obtain the advice of John Hays Hammond in this emergency. Mr. Hammond recommended them to draft B. B. Thayer. Nobody could be better. Mr. Thayer—the head of the Anaconda Copper Mining Co.—is not only a great engineer but also is one who worked himself up from the stopes, and during most of his long and active carrier he has had to do with the mines of Butte where the problems of timbering are of the first order of magnitude.

How Copper Is Bought

A characteristic of the copper market in recent years has been the buying of copper in great operations extending over a period of two or three weeks, followed by a period of two or three months during which the market is dull, relatively little business being done. With a production of refined copper at the rate of 150,000,000 lb. a month there must be sold about 6,000,000 lb. per day, or 36,000,000 lb. per week, on the average, to dispose of the output of new copper. Taking into account the reclaimed copper—the product of the junk smelters—and the speculative business, and occasionally the reselling by consumers themselves, the aggregate of transactions in copper exceeds an average of 6,000,000 lb. per day. With so huge a business it is unlikely that there is ever a day without some transaction by somebody, but with a total of three or four million pounds per day the market would doubtless be described as dull. After a long period of such a market there comes what we speak of as a "great buying movement," when during a week there may be sales of 100,000,000 lb. of copper, or in a fortnight twice as much. The buying in this way has been becoming more and more pronounced. What is the reason for it?

We may offer an explanation without getting at the reason. The explanation is that the American consumers have got the idea of acting in concert. They remain out of the market together and come in to buy together. More and more do they appear to be acting in concert. What is their reason will have to be surmised. Of course they figure on buying their copper more cheaply than otherwise—a matter that is well worthy of consideration; for has not Mr. Ryan pointed out several times that the American consumer has in the past paid considerably more for his copper than the foreigner? But do they figure that by their concerted abstention they will tire out timid producers and thus obtain cheap copper? It is certain on the other hand that when they try to buy at the same time they hoist the price up on themselves, perhaps 1c. per lb. between the opening and closing of a day, whereupon they accuse somebody other than themselves of rigging the market.

If consumers abandoned the idea of playing a speculative game, if each one bought his copper as he needed it, we fancy that things would be better for them in the long run. But while the present policy obtains we may look for periodic "buying movements," intermediate spells of dullness, slow declines in price and sudden, sharp upturns, and in general conditions more erratic than they ought to be.

Lead Smelting Developments in the Coeur d'Alene

Interesting news comes from the Coeur d'Alene, where the relations between the miners and smelters, especially the A. S. & R. Co., have been simmering for a long time. The mines of this district have heretofore been tied up with long-running contracts under which they have been restive. The pros and cons of this controversy need not now be discussed. The complaint was directed chiefly against the A. S. & R. Co., but there was competition in the district by other smelters—the International, Ohio & Colorado, United States and Pennsylvania. However, the terms offered by them have not differed greatly. Of course, the Coeur d'Alene ore has always been regarded by the smelters as a marginal ore—that is, one out of which they should make a profit—whereas in some other districts lead ores have been taken at a loss, the profit being earned from other classes of ore. Nevertheless, there are some features in the Coeur d'Alene contracts that have always seemed to us to be objectionable. Especially so is the arrangement whereby the price for lead is based upon a certain arbitrary figure, the difference between that price and the market-price, when the latter is in excess, being divided between miner and smelter on the basis of 50-50.

Anyway, the dissatisfaction of the mining interests expressed itself not long ago when certain stockholders of the Federal Mining and Smelting Co. brought suit against the A. S. & R. Co. for annulment of contract. This year the Hercules contract expired and the owners of that mine refused to renew. Through the Tamarack & Custer Mining Co., in which they are interested, they have acquired the old smeltery at Northport, Wash., which they are rebuilding, and hereafter they propose to do their own smelting there.

Now comes the report, officially verified, that the Bunker Hill & Sullivan company is going to do its own smelting. Whether this will be in the Coeur d'Alene or at some place on the Pacific Coast has not yet been determined. The controlling interests of this company have had experience in smelting, being formerly concerned in the Tacoma Smelting Co., which they sold out to the American Smelters Securities Co.

This is a more formidable insurrection in the lead-smelting business than the A. S. & R. Co. has ever had to face. Both the Hercules and the Bunker Hill & Sullivan companies possess ample resources and are well able to carry through anything they undertake. The Bunker Hill & Sullivan company is sure to be well advised, both technically and commercially. It is to be hoped that the Hercules people also will get the right kind of assistance. It is but natural that these big mining companies should want to do their own smelting. That they are taking steps in that direction is an interesting and healthful development.

The policy of watchful waiting for things to happen in Mexico still prevails, the present idea being evidently to wait for Carranza to get the upper hand and then recognize him. The stars of Villa and Zapata are waning unmistakably. Probably it was fear of further turbulence in the north, following the disruption of Villa's army, that inspired the new warning to Americans to leave Mexico. Shall we venture to hope for the peace of weariness? It looks as if that were the only kind of peace there would be, for Washington will not contribute toward anything else. Our Mexican policy is still an enigma. Poor little Haiti indulges in rioting and the Administration goes down there overnight, assumes a protectorate and does not turn a hair over the job. Is it merely a question of size, not of principle?

The sale of the Midvale Steel Works in Philadelphia, one of the three producers of armor-plate and heavy ordnance in this country, to a strong financial syndicate has started up again the reports of a new steel combination with rather more appearance of probability than before

PERSONALS

C. C. Semple has gone to Nacozari, Mexico, expecting to remain for several weeks.

George P. Wilson, of Salt Lake, was in San Francisco at the Engineering Congress meeting.

E. Norris Hobart has recently been examining lead-silver prospects in the Alamo District of Texas.

Prof. T. L. Walker, of Toronto University, recently spent a week in Kootenay district of British Columbia.

C. H. Poirier is consulting engineer for Dominion Gold Mines, Ltd., operating in Munro Township, Ontario.

W. L. Cumings, of the Bethlehem Steel Co., is in Chile from which he expects to return in November or December.

W. H. Wright, of the Malm-Wolf Co., has completed placer xaminations in northern Idaho and has gone to Seattle.

J. M. Bidwell, manager of the Murray plant of the American Smelting & Refining Co., is visiting San Francisco.

Albert G. Wolf has completed mine-examination work in northern California and western Nevada and has returned to Denver.

J. H. Stovel, of the Mond Nickel Co., formerly in charge of the Frood Extension, is opening the Bruce Mine for the Mond company.

Corey C. Brayton has returned to San Francisco after a summer's work examining dredging ground in the Lowe District in Alaska.

Charles J. Harrah, for many years president of the Midvale Steel Co., has retired from that position, having sold his large interest in the stock.

J. H. Curle has been detached from field service in the British Army and has been detailed as assistant to the Parliamentary Savings Committee.

John W. Swift, auditor of the Bureau of Mines and acting secretary to Director Manning, is in San Francisco to assist in he field meet under the auspices of the Bureau.

Justin S. De Lury, a graduate of the University of Toronto, and for some years on the staff of the University of Idaho, has accepted a position as lecturer in geology at the University of Manitoba.

Capt. John L. Retallack, of Kaslo, B. C., long actively connected with mining in Ainsworth and Slocan mining divisions of British Columbia, is now in England with other soldiers from that province.

Karl Eilers, member of the executive committee of the American Smelting & Refining Co., in charge of the metallurgical department in the Western states, is visiting the Panama-Pacific Exposition.

George S. Rice, chief mining engineer, and J. W. Paul, chief rescue engineer, of the Bureau of Mines, are in San Francisco at the Panama-Pacific Exposition in connection with the first-aid and rescue demonstrations.

H. B. Zeller, assistant superintendent of the coke plant of the Republic Iron & Steel Co. at Youngstown, has resigned to become superintendent of the new byproduct plant of the Toledo Furnace Co., Toledo, Ohio.

Chas. A. Banks, general manager of the Jewel-Denero Mines, Ltd., has returned to the Jewel mine, near Greenwood, B. C., from a trip to Cobalt and Porcupine districts and thence to Chicago, St. Louis and Salt Lake City.

S. I. Silverman, of Spokane, Wash., is arranging to send into the Stikine mining division of British Columbia supplies for a party of men who will spend some time in prospecting and developing mineral claims in that country.

J. H. East, foreman miner, K. H. Chism, first-aid miner, and C. J. Roberts, engineer, are at the Panama-Pacific Exposition with the new rescue car which is on the Exposition grounds used in connection with the demonstration of first-aid and rescue work.

C. J. Hicks, formerly assistant to the president of the International Harvester Co., has been appointed executive assistant to President J. F. Welborn, of the Colorado Fuel & Iron Co. His duties will relate to social and industrial betterment of the company's employees.

Harold C. E. Spence returned recently from Europe where he has been associated with various oil-shale interests and is now directing development and distillation at the oil-shale enterprises in Newfoundland and Nova Scotia. His present address is New Glasgow, Nova Scotia.

G. H. Dowell, assistant general manager of the Copper Queen Consolidated Mining Co., Bisbee, Ariz., attended the conventions in San Francisco and visited the Exposition where his company is represented in "the mine." Mr. Dowell addressed the Mining Congress on the "History of Mine Taxation in Arizona."

J. H. Farrell has resigned the position of consulting engineer to the Yellow Aster Mining and Milling Co. In April, 1914, Mr. Farrell completed a geological report upon the Yellow Aster mine and was subsequently retained during the initial period of new work planned as a result of the examination.

OBITUARY

Paul Gottheil died in New York, Sept. 21. He had been for 42 years connected with the firm of Funch Edye & Co., beginning as office boy and rising gradually by capacity and hard work to be head of the firm. His death is mourned by the metal trade, which for many years had dealings with him as agent for the Rotterdam Line, to which port heavy shipments of copper have been constantly made. In shipping circles he was regarded as one of the leaders and was frequently called upon by the Government as a shipping expert.

Andrew Gordon French died on Aug. 16 last at Glasgow, Scotland, at the age of 78. He was well known in Nelson, B. C., where he spent several years working on the French process for the treatment of complex ores. Mr. French, who was a metallurgical chemist, spent most of his life in the study of the treatment of complex ores. While in Swansea, Wales, he invented a process for the treatment of the Constantine zinc ores, which are mined in Algeria. He spent several years in Australia studying the treatment of the complex ores of that country and was associated with the Broken Hill Proprietary Co. in New South Wales.

Ralph Baggaley died in Pittsburgh, Penn., Sept. 23, aged 68 years. He was born in Allegheny, Penn., was educated in the schools there and at Dresden, Germany, where he remained two years. He was a man of great activity of mind and marked business ability, and was interested in many enterprises in the course of his active life. His first business connection was with the firm of Bollman & Co. Later he joined George Westinghouse, who was then working on his invention of the air brake. Mr. Baggaley took the business side of the enterprise and organized the Westinghouse Air Brake Co. which he brought into a prosperous and successful condition. Later he reorganized and successfully managed the Westinghouse Manufacturing Co. About 1875 he went into the newspaper business and bought the Pittsburgh "Telegraph" and "Chronicle," consolidating the two papers and managing them for some years. After the panic of 1873 he had bought some large tracts of land in the Lake Superior country, but he never mined there, and later sold his properties, which are now operated by the Oliver Iron Mining Co. In 1880 he bought coal lands in the Connellsville region and organized the Hostetter-Connellsville and the Puritan Coke companies, which subsequently became interested in mining coke combination. About 1901 he became interested in mining property in Butte, Mont., and organized the Pittsburgh & Montana Mining and Smelting Co. While managing that company he became interested in new processes of smelting and converting and took out a large number of patents for processes and machinery. Of recent years he has not been active in business except in connection with the United States Glass Co. In 1879, with the late Henry W. Oliver, Mr. Baggaley organized the Duquesne Club. He was also a charter member of the Pittsburgh Club. Mr. Baggaley was also a life member of the American Association for the Advancement of Science, of the Strollers' Club of New York, the Art Society of Pittsburgh, the American Institute of Mining Engineers and the American Society of Mechanical Engineers. He was also a member of Franklin Lodge, F. & A. M. He leaves a widow, two sons and four daughters.

SOCIETIES

American Institute of Mining Engineers—The October meeting of the Montana Section will be held Oct. 8, at the Silver Bow Club, Butte, Mont. A technical session will be held immediately after the dinner. The following paper will be read and ample time provided for discussion: "Preliminary Outline of Paper on Mines in the Boulder Batholith." By J. A. Grimes and Paul Billingsley.

Editorial Correspondence

SAN FRANCISCO—Sept. 22

Highgrading at the Empire Mine in Grass Valley has been exposed by the arrest and alleged confession of A. H. Coggins, formerly employed as specimen boss at the Empire. It was reported that the cache contained $35,000 worth of high-grade and specimen ore alleged to have been stolen from the Empire mine. Coggins was a trusted employee of the Empire and probably would not have been suspected had not the other men given the information.

A Lead-Smelting Plant will be built by the Bunker Hill & Sullivan Mining and Concentrating Co. F. W. Bradley, president of the company, is authority for the statement that ample funds have been accumulated and saved for this purpose and that the engineering and construction work will be done by the firm of Bradley & Labarthe. The plant will be located either at the mine or on the Pacific coast, according to which point affords the most favorable operating and transportation facilities.

Production of Petroleum in all fields in California in August totaled 7,680,047 bbl. Midway-Sunset field produced 3,334,516 bbl.; Coalinga, 1,148,678 bbl.; Whittier-Fullerton, 1,053,375 bbl.; Kern River, 791,445 bbl. All the other fields produced less than 500,000 bbl. each. Total shipments from fields in August amounted to 7,924,656 bbl. The total crude stocks on hand Aug. 31 were 60,162,277 bbl. Only 12 wells were completed in August. This is the lowest record of new wells in any month since February, 1907. It is plain evidence of the inactivity in the fields. The small decrease in production in August as compared with July, amounting to 58,596 bbl., is merely added evidence of the necessity for curtailing production until the market conditions caused by the war have been improved. The operators have the satisfaction of knowing that the oil is still in the ground.

DENVER—Sept. 23

Ore Buyers in This State have suddenly realized the existence of a law passed last winter by the legislature. In an effort to stop the practice of highgrading—especially in the Cripple Creek district—the lawmakers made it compulsory upon all purchasers of ore (of any sort) to fill out a prescribed document and to pay the secretary of state an annual license fee of $100. This official has announced that he has set Nov. 1 as the date after which this law will be rigidly enforced.

United States Reduction & Refining Co. Officials believe the bill of complaint filed some time ago by the New York Trust Co. was a direct attempt to remove them from competition in the ore-purchasing business. The Golden Cycle company operates its big mill at Colorado City close to the disused plant of the United States company. Judge Lewis, of the United States district court at Denver, on Sept. 11, overruled the United States company's motion to dismiss the case. J. Arthur Connell was named receiver, it being proved that the Reduction company had defaulted in the payment of interest on bonds held by the Trust company. The Reduction company was given 10 days in which to answer this action, after which the original case will be held on its merits.

Defunct Mining Companies in Colorado—Secretary of State Ramer has gone over his records and has declared the following corporations defunct and inoperative and no longer competent to transact business within the state of Colorado. The list may prove of interest to readers who have stock or other interests in these corporations whose activities were in mining, metallurgical and allied branches. Almont Mining Co.; Amphitheater Gold Mining Co.; American Consolidated Gold Mining Co.; American Gold Standard Mining Co.; American Ozokerite Mining Co.; American Star Mining and Milling Co.; Anderson-Halter Mines Co.; Annamosa Mining Co.; Arcade Mining and Milling Co.; Argentine Milling Co.; B. & O. Mining, Milling and Manufacturing Co.; Badger Mines Co.; Barnes Mining Co.; Bernadette Tunnel Mining and Milling Co.; Berthoud Mining Co.; Beam Converter Mill Co.; Belvidere-Leadville Mining Co.; Big Six Mining Co.; Big Five Tunnel, Ore Reduction and Transportation Co.; Brandon Gold Mining Co.; Bright Star Mining and Milling Co.; Buckley Mining Co.; Burns-Moore Stockholders Leasing Co.; Boston & Cripple Creek Gold Mining Co.; British American Mining Co.; Cashen Mining and Leasing Co.; Cosmopolitan Mining and Leasing Co.; Cripple Creek Free Gold Mining and Milling Co.; Cripple Creek Mining and Leasing Co.; Diamond M. Leasing Co.; Champion Mining and Milling Co.; Clear Creek Mining and Leasing Co.; Cloud City Mining Co.; C. M. S. Mines Co.; Cottonwood Mining and Milling Co.; Colorado Apex Mines Co.; Colorado Fluorspar Mining Co.; Colorado Gold Mining and Investment Co.; Colorado Gold Reserve Mining Co.; Colorado-Idaho Mining and Exploration Co.; Colorado-Idaho Mines and Development Co.; Colorado Molybdenum Co.; Colorado Smelting and Mining Co.; Colorado-Toledo Mining Co.; Conniemac Mining and Realty Co.; Continental Consolidated Mines Co.; Copperfield Reduction Co.; Creede United Mines Co.; Creede Local Mining Co.; Crown Lode Mining Co.; Curtis Dry Placer Machine Co.; Development and Mines Co.; Deerfield Mining and Milling Co.; Deadwood-Dallas Placer Co., Delmas Mining and Milling Co.; Denver Leadville Mining and Tunnel Co.; Denver Mining and Reduction Co.; Denver Mining Investment Co.; D. Pendon Leasing and Mining Co.; Earle Concentrator and Manufacturing Co.; Eagle Mining Co.; East Bellman Mining Co.; East Lake Mining Co.; El Valle Mines Co.; Emery Baryta Mining and Separating Co.; Empire Mines Co.; Excelsior Consolidated Gold Mining Co.; Excelsior Drill and Manufacturing Co.; Federal Graphite Co.; 4-C Mine, Mill and Tunnel Co.; Frisco Mining, Milling and Development Co.; Francesca Mining and Leasing Co.; Fredonia Mine and Milling Co.; Frisco Milling Co.; Gilpin Mining and Leasing Co.; Gladys Gold Mining and Development Co.; Globe Mining, Milling, Power, Lighting, Drainage and Tramway Co.; Gold Divide Mining, Milling and Tunnel Co.; Gold Hammer Mines and Tunnel Co.; Gold Ledge Mining Co.; Gold Queen Mining, Milling and Development Co.; Goldwin Mining and Milling Co.; Golden Amethyst Mining Co.; Golden Age Mining and Reduction Co.; Great Nevada Mining and Milling Co.; Great Western Copper Mining Co.; Guerrero Mining and Exploration Co.; Gypsy Mines Co.; Hawkeye Consolidated Mines Co.; Hanna Mining and Milling Co.; Handies Peak Gold Mining and Milling Co.; Hibbs Mining and Milling Co.; Howard Mines Co.; Horn Rotary Slime Concentrator Co.; Ida Mining and Milling Co.; Incidental Gold Mining Co.; Independence Placer Mining Co.; Interstate Mining and Milling Co.; Jewell Mining and Milling Co.; Kerns Colorado Mining Co.; Kings Phillips Mining Co.; Laurium Mining Co.; Last Chance Mining, Milling and Tunneling Co.; LBS. Mining and Leasing Co.; Lenawer Mining, Milling, Tunnel and Transportation Co.; Leadville Smelting and Reduction Co.; Lilly Levy Mining and Milling Co.; Little Muggins Mining Co.; Lotta J. Mining Co.; Lucky Strike Gold Mining Co.; Mammoth Gold Mining Co.; Mackey Gold Mining and Milling Co.; Manhattan Placer Mining Co.; Marks Pulverizing Mining and Milling Machinery Co.; Mary Jane Mining and Milling Co.; Mary Ellen Gold Mining and Leasing Co.; Melba Mines Co.; Meriden Mining Co.; Miami Mines Co.; Mono Baltic Mining and Smelting Co.; Montezuma Chiefs Mines Co.; Mountain Peak Gold Mining Co.; Mountain Mining and Investment Co.; Murray Mining, Milling and Leasing Co.; Muscovite Mining Co.; McCulloch Mines Co.; McNulty Gulch Mining and Milling Co.; McQuarrie Creek Placer Mining and Prospecting Co.; Navarrio Mining, Milling and Tunnel Co.; National Mining and Investment Co.; New England Gold and Copper Mining Co.; Newark Gold Mining Co.; New England Mining Co.; North American Smelter and Mines Co.; North Creede Mining Co.; North American Ore Purchasing Co.; Nellie K. Gold Mining, Milling and Leasing Co.; Northwestern Leasing, Mining and Milling Co.; Occidental Exploration Co.; Oklahoma and Colorado Mining and Milling Co.; Ophir Tidal Wave Mining Co.; Oriole Mining Co.; Onida Gold Mining Co.; Pine Twentieth Century Manufacturing and Reduction Co.; Pittsburgh-Ely Copper Co.; Plymouth King Mining and Milling Co.; Prussian Gold Mines Co.; Princess Alice Gold Mining and Milling Co.; Providence Mining and Milling Co.; Protection Mining Co.; Quaker Mining and Milling Co.; Raymond Tunnel and Mining Co.; Red Mountain Gold Mining Co.; Red Cloud Gold Mining and Prospecting Co.; Reinforced Cement Mining Timber Co.; Reliance Gold Mining Co.; Reinert Gold Mining Co.; Recovery Concentrating Milling and Mining Co.; Red Oak Gold Mining and Milling Co.; Rexall Gold Mining Co.; Rhyolite Placer and Mining Co.; Ridge-Mexico Mining and Milling Co.; Rosebud Gold Mining and Milling Co.; Rocky Mountain Rare Metals

Co.; Rockyfellow Mining and Milling Co.; Rocky Mountain Mine Development Co.; Saratoga Mining Co.; Sand Mountain Mining, Leasing and Industrial Co.; Silver Wave Mining Co.; Silver Princess Mining Co.; Silver Horn Mines Co.; South Homestake Mining Co.; Spanish Basin Gold Mining Co.; Square Deal Mining, Milling, Drainage, Tunnel and Transportation Co.; St. John Extension Mining and Power Co.; Stahler Concentrator Co.; Swedish-American Gold Mining and Milling Co.; Treasure Mining and Reduction Co.; Tasmania Copper Mining and Milling Co.; Teal Brothers Mill and Mines Co.; Ten Spot Mining, Milling and Leasing Co.; Thomson Mining and Milling Co.; Tomahawk Mines Co.; Two Brothers Gold Mining and Milling Co.; Two Thousand Two Gold Mining Co.; Uncle Sam Gold Mining Co.; Union Consolidated Mining and Milling Co.; United Mines Corporation; United Colorado Mines Co.; United States Mining Corporation; U. S. Smelting and Refining Co.; Walter A. Weber Mining Co.; Western Ore Reduction Machinery Co.; Western States Mining and Milling Co.; Western Investment Co.; Western Ore Reduction Co.; Whale Mining and Developing Co.; Whitepine Mining Co.; Woods Investment Co.; World's Fair Gold Mining and Milling Co.; Wynn Gold Extraction Co.; Yellow Medicine Gold Mining and Milling Co.; Yellow Metal Gold Mining, Milling, Water, Irrigation and Power Co.; Yreka Mining and Milling Co.

In addition to the above Colorado corporations, the following corporations of so-called "foreign" standing have been declared debarred from doing further business in this state: Alameda Gold Mining and Milling Co.; Anaconda Mining Co.; Argonaut Gold Mining Co.; Burns Moore Mining and Tunnel Co.; Buckeye Gold Mining, Milling and Tunnel Co.; Colorado Ore Reduction Co.; Dorex Mining and Milling and Tunnel Co.; Elkhorn Tunnel and Mining Co.; Futurity Mining and Milling Co.; F. M. & D. Copper Mining Co.; Gold Issue Mining and Milling Co.; Governor Mining Co.; Huntington Gold Mining and Milling Co.; Kansas City Tunnel Site Mining Co.; Mines Intersection Syndicate, Ltd.; Mineral Point Gold Mining Co.; Mines Developing Co.; Prize Mining Co.; Refractory Ores Recovery Co.; Retla Mining Co.; Rhyolite Beacon Gold Mines Co.; Shenandoah Gold Mines and Smelting Co.; South Mosquito Mining Co.; Suffolk-Globe Mining and Milling Co.; St. Paul Mining, Milling and Investment Co.; Teutonic Consolidated Gold Mines Co.

SALT LAKE CITY—Sept. 23

The Magna and Arthur Mills of the Utah Copper Co. are now treating 30,000 tons of ore daily; 18,000 tons going to the Magna, and the remainder to the Arthur. Some ore running 3 to 4% copper is being handled. There are now employed at the mine and mills about 3,300 men.

The Fatal Accident in the Albion at Alta, mentioned in the news item of the "Journal" last week was due, not to the failure of the oxygen helmet as at first supposed, but to the fact that the men wearing the helmets remained at their work too long and the 30-min. supply of oxygen was exhausted, after which they were overcome by the carbon-dioxide gas. The two men wearing the helmets were both experienced. One of them was Captain Andrew E. Eikram of the Salt Lake Fire Department, a veteran "smoke eater," and the other was James Hendrickson, a mining engineer of experience, formerly employed in mine-rescue work by the United States Government. The oxygen helmets were borrowed from the Salt Lake Fire Department. The work of rescuing the body of James Hendrickson who was suffocated was accomplished by A. O. Jacobson with a party of five experienced miners of his selection. Instead of equipping his men with oxygen helmets he gave each man a hammer and a steel punch. They advanced into the workings and every four feet a man punched a hole in the air pipe. In the meantime air was forced into the pipe line at the highest pressure possible. By tapping the pipe at frequent intervals the rescue party was well supplied with fresh air and reached the body of Hendrickson who had been dead for several hours.

SEATTLE—Sept. 22

Another Third Beach Line has been uncovered on the Seward Peninsula, this time at the original delta of the Solomon River, five miles east by north of the present mouth of that stream and 35 miles from the great beach at Nome. News of the discovery similar to that at Nome which produced $20,000,000 has caused a wild stampede from the Nome district and everything for miles around the new discovery has been staked. The new beach is at the Nome level and was uncovered by H. G. Harvey and Otto Halla. A cross-cut made shows that the beach deposit is nearly 275 ft. wide, carrying pay 5 ft. deep. The theory advanced and generally accepted at Nome for several years that the beaches are all on the east and west course are entirely upset by this discovery, the course there being northwest and southeast. It forms, in fact, a half-moon bay. Search for such a beach has been in progress since the discovery of Nome and immediately after the discovery of the third beach line at Nome which turned out such enormous profits, prospecting activities were carried on at nearly all the larger streams on the peninsula emptying into Bering Sea and notably on Solomon. A beach was found near Pine Creek but this proved to be barren of gold. Enough information was gained to establish the fact that there were three beach levels on the Solomon River but following the discovery of a high gravel bank carrying little gold it was presumed that the beaches would not produce much and active prospecting was abandoned. These same gravel banks under the prospecting of Harvey proved to be the delta of the ancient Solomon River and formed the bed of the stream, the surf washing and concentrating the gold up the hillside. The discovery has caused the biggest stir in the Seward peninsula since the discovery of the third beach line at Nome.

Chisana Development is Active and a good production is being made considering the fact that the season has been backward and water has been scarce. Some exceptional cleanups have come from Bonanza Creek which contained considerable coarse gold. On Bonanza Creek, Briggan & Hocker, with a crew of 5 men, is working on the lower end of No. 7 and John Ludwig and partner are sluicing on No. 7 Fraction which was worked successfully last season by William Taylor. The ground on No. 9 is being stripped with a hydraulic nozzle by Billy James, the discoverer, and his brother. F. T. Hamshaw has a crew of 12 men at work on the lower end of No. 5 in ground that is still frozen at bedrock. He also has a crew at work on No. 6. Good results are reported by Max Altman's crew on the upstream end of No. 6, where they have taken out a number of cuts. On Johnson Creek, Hawkins & Dahl has made good progress on the claims between the town of Chisana and Bonanza. On Little Eldorado, Johnson & McGovern is working on No. 1 on the left limit at the upper end and taking out rich dirt. Carl Whitham is sluicing on No. 2 and W. McLennon is sluicing on No. 3. W. E. Nelson is working on No. 3 Snow Gulch and Eagan & Co. is sluicing on No. 1 Coarse Money Creek. On Big Eldorado cleanups are made regularly on 4 below upper discovery. The flume now supplying a number of the operators is being extended by James & Nelson and will enable Bob Clark and his partners on the lower end of No. 10 to carry on greater sluicing activities. Wright & Anderson on the upper end of No. 11 Fraction has a small crew sluicing good ground. Considerable prospecting is going on on various creeks in the immediate neighborhood, notably on Lucky Pup and Cañon Creek, Shamrock Creek and Coarse Money. Pay is now being taken out and regular cleanups being made by about 150 operators, the greatest number working in the district since its discovery, and the output is expected to be much greater than in 1914.

SPOKANE—Sept. 22

"Both Plants of the Granby company are running at full capacity and between them turning out copper at the rate of 3,500,000 lb. per month, or 42,000,000 lb. per year," said Frank M. Sylvester, general manager of the Granby Consolidated Mining, Smelting and Power Co., while in Spokane this week, after his return from a visit of inspection to both Anyox and Grand Forks, B. C. "The Grand Forks smelter has eight furnaces in operation, treating 100,000 tons of ore monthly. At Anyox, the fourth furnace was blown in about Aug. 15. The tonnage of ore treated there averaged 62,500 tons monthly during May, June and July. In August, 75,000 tons were handled. The working force at Anyox, where there is more or less construction still going on, is between 850 and 900 men. About a year ago the company added the Bonanza mine on Granby Bay to its holdings, but we have done nothing yet toward putting it in shape for production, as we do not need the ore. We also acquired some idle and supposed-to-be worked-out mines on Prince-of-Wales Island, Alaska. We have been taking a little ore out of them, mainly from the Mamie, worked at one time by Sam Silverman. The Midas mine, at Valdez, Alaska, we have put into shape to ship, but we have had no ore from it yet, owing to the scarcity of boats in those waters. We have plenty of work in sight to keep one steamer busy, so we may be forced to buy one. We are encouraging miners in northern British Columbia and Alaska to the best of our ability, but not much custom ore has come to us yet. About the only considerable shipper has been the Rocher de Boule mine, near Hazleton, B. C., which has sent us 6,000 tons in the last two months."

The ore from the company's mines near Anyox averages from 1.4 to 2.2% copper and the gold and silver amounts to about 30c. per ton.

GOLDFIELD, NEV.—Sept. 25

Conditions in the Goldfield Camp would seem to be pretty well reflected by the dismal aspect of the city as compared to what it was five years ago. Numerous vacant stores and buildings, with "For Rent" or "For Sale" signs displayed, rows of houses in a dilapidated condition, and the conditions of the streets themselves bespeak the departure of the prosperity they once enjoyed. The Goldfield Consolidated is of course treating more ore per day now than it did formerly, the amount averaging over 1,000 tons per day; some work is being done by the Merger company, by the Jumbo Extension, Kewanas and a few other properties, but despite this, evidences of healthy activity are not apparent. Business is dull, and one hears a good deal of conversation about whether Goldfield can "come back" or not. Others look forward to better things this autumn, but generally admit that such betterment will come rather from strengthening of the stocks than from improvements in the mines. The impressions of a visitor to the camp are, however, that it needs the stimulus of an important discovery to revive it from its present torpidity.

Tonopah Conditions, despite the low price of silver, are in strong contrast with those obtaining in Goldfield. The larger companies such as the Tonopah Mining, Tonopah-Belmont, Tonopah Extension and West End are running at the full capacity of their mills, while the many properties that operate no treatment plants but dispose of their ores to the other companies, are for the most part keeping up production, and none of that laxity is apparent that in some places gives a "run-down" impression not always merited. The town seems fairly busy and prosperous, a healthy tone being maintained, perhaps due as much to activity in camps adjacent to Tonopah as in the place itself. Several miles out from Tonopah, recent work has disclosed the existence of good-grade ore containing silver, gold, copper and lead. Several such disclosures have been made but apparently little has so far been done toward determining their worth. Leasers seem to be numerous and generally report satisfactory results; leasing, apparently, being on the increase. Considerable interest is being taken in the camp of Manhattan where gold is being found both in placers and quartz veins. Tonopah people are interested, and there is a considerable amount of automobile traffic between Tonopah and Manhattan. The MacNamara mill has just been cleaned up for turning over to the company by Jones and Carpenter who had leased the plant to treat sweepings from the old tailings pond, it being stated that results were not financially successful. The Tonopah Mining Co. has now a full staff at its gold property in the Pis-Pis district in Nicaragua. This property, now known as the Eden, was originally the Panama mine which was developed by Philadelphia men. A larger proportion of foreign laborers is employed in the Tonopah mines now than formerly, but recently there has been quite an exodus of Montenegrins and Serbians who are returning home to go to war.

WALLACE, IDA.—Sept. 23

A Lead-Smelting Plant for the Coeur d'Alenes is assured since it is authoritatively announced that the Bunker Hill & Sullivan Mining and Concentrating Co. will build a smeltery to treat its own ores. The purpose of the company became known to the public through A. E. Goodell, formerly northwestern representative of the International Smelting & Refining Co., who it is now learned has been in the service of the Bunker Hill & Sullivan company most of the time since severing his connection with the International. Mr. Goodell is now engaged in securing easements from owners of land in the vicinity of the proposed plant a short distance below Kellogg, and upon his success depends the definite location of the plant. If he is successful in obtaining releases from possible smoke damages, the smeltery will be built a short distance from the mine; otherwise the company will select a site at some favorable place on the coast. No difficulty is anticipated, however, and it is practically certain that it will be located near the mine. The announcement that the Bunker Hill & Sullivan would go into the smelting business created almost a sensation in mining circles, following so closely the action of the Days in buying and rebuilding the old Le Roi smeltery at Northport, Wash. It will be recalled that on May 31 last the Hercules contract with the American Smelting & Refining Co. expired, and because the smelting company declined to renew it or to make satisfactory terms in a new contract, the Hercules mine, of which the Days are the controlling owners, closed down, and the next move in the controversy was their purchase of the Northport which is now being remodeled preparatory to handling the output of the Hercules and the Tamarack & Custer another Day-controlled mine. The fact that Harry L. Day is still retained as president and general manager of the Federal company, a subsidiary of the A. S. & R. Co., and the further fact that the A. S. & R. Co. is still treating Hercules ore pending the completion of the Northport plant, has created the impression that the American is in reality back of the Days in that enterprise. Assuming that this impression has a substantial basis, the action of the A. S. & R. Co. is explained by the terms of its contract with the Bunker Hill & Sullivan. The Bunker Hill contract is for 25 years and has 15 years to run, and it stipulates that it may be revised every five years to conform to the terms upon which "a majority" of the ores of the district are being smelted. By a significant coincidence the date for revision was on June 1, the day following the expiration of the Hercules contract, which represented "a majority" of the ores outside of the Federal company owned by the smelter. To renew the Hercules contract meant that the Bunker Hill & Sullivan would have to be given the same terms, or a reduction of $2 from the present rate of $16 per ton for freight and treatment, and the full New York quotation for 90% of the lead content. That it was to avoid making these concessions to the Bunker Hill & Sullivan, and also to the Stewart, is the basis for the belief that the A. S. & R. Co. is back of the Days in the Northport enterprise. This is also accepted as a reasonable explanation of the action of the Bunker Hill & Sullivan in deciding to smelt its own ores. It will also handle the output of the Caledonia, Ontario and Sierra Nevada, which are closely affiliated with the Bunker Hill either by ownership or lease. It is also believed that the new plant will handle the ore from the Hecla and Marsh upon the expiration of their contracts with the International.

METALINE, WASH.—Sept. 23

There is Considerable Activity in the Metaline mining district, Stevens County. The Metaline Oriole Mining Co. will start work on a 50-ton concentrating mill Oct. 1. The lumber has been contracted for. The capital stock of the company is assessable and the assessments will be continued until this mill is up and in operation; there is estimated to be $25,000 worth of ore now in sight. The Zinc-Lead Co. installed a 50-ton concentrating mill on its property this summer and has been running 60 days and is shipping a car load of concentrates every week. It is now making arrangements to install a ball mill and increase the capacity of the plant to 200 tons per day. The ore is averaging about 16% zinc. The Silver-Lead Co. will start work next week on its lead property just below the Falls. It will continue the lower tunnel which will cut the ledge in about 100 ft. It is rumored that the Sterling Silver Co. has bonded its property to some Spokane people, who are on the ground now and expect to put about 12 men to work immediately. The company is the owner of 16 patented claims. The Riverside property expects to start work early in October. The Proudy brothers will be in next month to work all winter. They have a very promising copper prospect. They will work four men. The camp in general is looking very good—much better than ever before. Every one seems to be very anxious to do much more than the usual assessment work and is making preparations now to do so. There is some chance of a several-million-dollar power plant going in at S Cañon. Hugh L. Cooper is now testing the ground for the big dam.

TORONTO—Sept. 25

The Northern Ontario Power Co. will increase the capacity of its power plants at Porcupine at a cost of over $500,000. The increased quantity of power is necessary to supply the growing demands of the Hollinger and the Dome and to take care of the future developments in the camp.

The Reported Discovery of Silver in the Fond du Lac District of Lake Athabasca has been reported on by Canadian Government geologists who were sent to investigate. They state that no minerals of economic importance have as yet been discovered in that country. There was a good deal of excitement last winter when high-grade silver was reported from Fond du Lac.

The David A. Thomas Interests, which for the last three years, have done extensive exploration work in the district to the north of Edmonton, Alta., have now begun active development. Three test holes for oil are being drilled at a point 3 miles above The Chutes, on the Peace River, near Fort Vermilion, under the direction of C. F. Law, of Vancouver, the Canadian representative of Mr. Thomas. Drillers have been brought from San Francisco with a modern plant capable of drilling 2,000 ft. Fifty men are engaged in the work of exploration. In order to provide adequate transportation on 2,400 miles of northern waterways, three large steamers are to be built and placed in commission north of Edmonton. The first of these is now under construction at Peace River Crossing by a force of 30 men brought from San Francisco.

The Mining News

ALASKA

QUARTZ CREEK MINING (Valdez)—W. W. Getchel has taken an option to buy the two miles of ground owned by this company on Quartz Creek in Moose Pass district.

ALASKA TREASURE CONSOLIDATED (Juneau)—Union Trust Co., of San Francisco, through E. S. Heller, its representative at Juneau, has purchased this property for $374,500. Sale is result of judgment recently secured. H. A. Bishop is vendor.

ALASKA TREADWELL (Treadwell)—New shaft at central hoist will soon be in place and in working order, again permitting full operation for first time in several months or since break which has been most costly this company has experienced in several years. Shaft was 20 in. in diameter and 40 ft. long and had to be shipped from Pittsburgh.

ALASKA COAL (Seward)—Captain J. A. Herbert, who was one of the first men to secure lease of coal lands from government, has completed arrangements to furnish Seward with lignite coal from his mine near Seldovia. Coal has already been used to advantage in new town of Anchorage and by several canneries to westward. It will be laid down in Seward at little over one-half price charged for soft coal brought from Seattle. Capacity of mine is 40 tons a day at present, but this output can be increased whenever demand warrants.

ARIZONA

Greenlee County

THE STATUS OF AFFAIRS IN THE CLIFTON-MORENCI DISTRICT is quiet and unchanged. President Moyer, of the Western Federation of Miners, is quoted as advising the union to yield on the point of recognition of the union and to have its committee meet the mine operators to discuss the wage scale, which the union claims is lower at Clifton and Morenci than at Bisbee, Ray, Miami or Globe; the reinstatement of men discharged since Sept. 1 for agitating recognition of the Federation; and assurances that there will be no discrimination against men who have led the strike or who have held out for recognition for the union.

CALIFORNIA

Amador County

VOLCANO DISTRICT is attracting attention of placer miners. Joseph Garibaldi recently made shipment of $1,200, being result of placer cleanup on ground that had been previously worked.

CENTRAL EUREKA (Sutter Creek)—Ore of good grade has been disclosed on the 3,200 level about 100 ft. south of the orebody on 3,100 level. At present 30 stamps are dropping but it is expected that full 40 stamps will be in commission in about two weeks.

Calaveras County

UTICA (Angels Camp)—D. Castle, miner working at the winze at Cross shaft, fell into the skipway, distance of about 40 ft., and landed on skip. He was badly injured on head, face and body but it is believed will recover. Had the skip not been below him he would have fallen a distance of 800 ft.

MONARCH MINING (Vallecito)—George Morris, of Sonora, and associates, of San Francisco, have taken bond on the Ora Plata gravel mine. Company owns 70 acres adjoining and also has bond on Sloane property. Tunnel from Coyote Creek under old channel for purpose of handling water is contemplated. Handling of water in district is problem that has disturbed miners in past.

Placer County

PIONEER (Towle)—Forty men are employed and about 1,800 tons of ore extracted per month. Improvement in grade of ore is reported.

DEWEY CONSOLIDATED (Iowa Hill)—Tunnel driven in to rim of channel disclosed gold-bearing gravel. Drift will be continued across the channel to opposite rim before saving gravel will begin. Property consists of 137 acres, said to be crossed by Blue Lead channel.

BIG OAK (Colfax)—Mine is being unwatered by F. N. Hubble and associates, who have taken property on purchase option. Development consists of shaft 190 ft. deep and some drifting. Mine was closed down 21 years ago by litigation. Mrs. Rose Werry, of Colfax, and Mrs. T. B. Valentine, of San Francisco, are owners.

SLUICE-BOX MINING is in progress on middle fork of American River. Number of men are working with primitive methods and taking out from $3 to $12 a day each. One miner is operating with diving suit, taking gold from crevices in river bottom. His wife works with him and runs the air pump.

Siskiyou County

COPPER ORES from property east of Fort Jones are being shipped to Kennett for treatment at Mammoth smeltery. Ore is hauled by wagons to Southern Pacific R.R. at Yreka and Gazelle. Recent road improvement will add other shippers of base ores.

Tulare County

PORTERVILLE MAGNESITE CO. (Porterville)—Magnesite deposits included in 80 acres of land east of Porterville will be developed. Reported that the company has contracts for 100 tons per day, delivery to begin Nov. 1. C. F. Woody, of San Francisco, is manager; H. L. Doyle, superintendent.

COLORADO

San Miguel County

COLUMBIA (Telluride)—Recent development by leasers has opened pay ore. Shipments are being made to Durango smeltery.

STANDARD CHEMICAL (Placerville)—Development work is in progress on this company's property in Paradox Valley, under direction of John I. Mullen, manager.

SMUGGLER-UNION (Telluride)—Has taken over Ice Lake and is installing pipe-line to conduct water to Blue Lake, whence it will be used at Bridal Vein generating station.

LA SALLE MOUNTAIN MINING AND MILLING (Telluride)—This is new incorporation formed to take over and develop group of gold-bearing claims in La Salle Mts. Incorporators are Galloway brothers, W. E. Rice and Clark Akers. Capital stock is $50,000. Small force of men is at work on preliminary development.

PRIMOS CHEMICAL (Vanadium)—Shaft sunk on Bear Creek property is down 400 ft. On account of high cost of pumping, company has pulled pumps from this shaft and will continue development of property by driving tunnel from surface to tap bottom of shaft. This tunnel, which is now in progress, will be about 500 ft. long. Company is operating seven 6-horse teams from mine to mill, each team making three round trips a day. Hauling about eight tons per load.

HUMBOLDT (Telluride)—Three shifts are now employed in adit being driven toward Humboldt shaft, which must be advanced 700 ft. to make desired connection. All ore mined from property on Ouray side of range will be hauled through Sheridan adit to San Miguel County portal, whence it will be trammed to Pandora mills for treatment. Electric haulage will be installed in adit and electric hoisting equipment placed at shaft. As soon as tramway terminal is finished, boarding house large enough to house 125 men will be built near portal of adit in Marshall Basin.

BLACK BEAR (Telluride)—Development on third and fourth levels has opened an 8-ft. vein of silver-lead ore. Property is operated by Colorado-Superior Mining Co. Isaac Nevela has recently been appointed manager. During first six months of 1915 the company milled 16,366 tons of ore in the Smuggler-Union mills where it leases 20 stamps. Total recovery amounted to $75,201; operating expenses were $69,221; net profit, $5,980. During period under review boarding house earned $791, making a total profit of $6,771. About 50 men are on payroll. Zinc concentrate which is shipped to Blende is worth about $600 a car and gold-silver-lead concentrate which is shipped to Durango is worth from $2,000 to $3,500 a car, averaging about 30 tons per car.

San Juan County

LEE (Silverton)—This property being developed by the Silver Crown Mining and Milling Co., with option to purchase, under management of Jas. T. Burns. Breast of main tunnel is now in 3 ft. of high-grade ore.

MAYFLOWER (Silverton)—American Ore Flotation Co. has made payment of $3,000 on purchase price of this property in Arastra Gulch, formerly owned by Gus Malchus. Purchasing company is sinking winze on vein from upper workings. A 6-ft. vein has been opened which is almost solid galena. It is planned to drive crosscut at lower level for purpose of determining downward continuity of shoot.

IDAHO

Shoshone County

AMY (Kellogg)—Inclined winze following ore is being sunk 1,000 ft. from portal of tunnel. Company plans to construct mill soon.

INDEPENDENCE (Mullan)—Working small force on property between Morning and Hunter mines. Have 5 ft. lead milling ore in upper tunnel. Company understood to be under control of Stewart Mining Co.

RAINBOW (Little North Fork)—Recently struck 8 or 10 in. of practically clean zinc ore and face of drift is mixture of zinc, lead and quartz. Little depth has been gained and surface showing indicates extensive orebody within 300 ft.

NELLIE (Osburn)—This old producer, lying in so-called "dry belt" between Wardner-Kellogg and Wallace, has been leased to Ernest Kelly and associates for three years. Ore is mainly tetrahedrite associated with silver.

CALEDONIA (Kellogg)—Raise to connect with the 75-ft. winze sunk from the main working tunnel last week encountered rich oreshoot which had been cut off in winze by fault. Ore is combination of lead and copper with very high silver content.

MAYFLOWER (Wallace)—This company, operating on Nine Mile, is encountering ore in lower tunnel being driven 300 ft. below No. 2, in which there is good body of shipping ore. Portal of lower tunnel is near railroad. Property has recently been equipped with modern compressor.

ST. LAWRENCE (Wallace)—This copper prospect is situated at head of Silver Creek near the Idaho-Montana boundary and is owned by Angus Sutherland, of Wallace. Work during past summer has consisted of driving in lower tunnel. First-class ore is being taken from upper tunnel and hauled to Saltese for shipment.

HIGHLAND-SURPRISE (Kellogg)—Has secured contract for entire output of lead and zinc concentrate and will

commence shipments at once. New mill, originally designed for 100 tons daily capacity, can treat 150 if crowded and is so constructed that it can easily be enlarged to 300 tons capacity. Raise is being driven on ore from Surprise drift to Highland Chief lower tunnel.

RICHMOND (Adair)—Planned to resume shipments from Richmond group of six claims lying 14 miles east of Mullan and 2 miles from Adair, Montana. Two cars are being loaded at Saltese. Fifteen men are employed at mine at present. Group was located 20 years ago by Charles Heidenreich and worked intermittently for number of years. In 1910 forest fires destroyed mine buildings and damaged timbering. Operations were resumed in 1914 and car of ore assaying 29.75% copper was shipped, but mine was again closed down. Gasoline engine is used for hoisting; drilling is done by hand. If developments are satisfactory aërial tram will be built from mine to Adair, with drop of 1700 ft. in 2 miles. There are three shafts on property, 50, 85, and 120 ft. deep. Crosscut adit taps vein at depth of 320 ft. Best showing is in 120-ft. shaft, where both drifts are in ore.

MONTANA

Silver Bow County

BUTTE & SUPERIOR (Butte)—August earnings, biggest for any month in history of company, were at rate of $4.50 per share, due principally to deliveries of spelter at higher prices during past few months.

BUTTE-DULUTH (Butte)—Federal court has not yet given decision in involuntary bankruptcy proceeding brought against Butte-Duluth Mining Co., but one is expected within week or ten days. Should decision be against bankruptcy petitioners, receiver, who was appointed before bankruptcy suit was brought, will resume operations at property, and he claims that he can, under present copper prices and lower price of acid, earn good profit on operations.

EAST BUTTE (Butte)—August production about 1,785,000 lb. of copper against 2,000,000 lb. in July. September will also show about latter figure, which was high production record for this company. June output was 1,500,000 lb. and May, 580,000 lb. In 10 weeks of operation company shows net profit of $303,000. Last year actual output of company was but 9,175,579 lb. of copper and in 1913 it was 14,401,108 lb., present production being at rate of 24,000,000 lb. per annum, and it is not unlikely that coming 12 months will show total of 25,000,000 lb.

DAVIS-DALY (Butte)—Find made by Davis-Daly on the 2,500-ft. level of Colorado mine is developing in importance. Drifting on vein has proceeded distance of 80 ft. and size of vein and quantity of ore is holding out well. For width of 10 ft. ore averages about 5% copper. It is claimed there are 3 ft. of copper glance in vein. Station is being cut at 2,500 and preparations are being made to stope ore. About 80 tons of ore per day are now being hoisted from Colorado. All this ore has been taken from sill floor in course of development work.

BOSTON & MONTANA DEVELOPMENT (Butte)—Good progress being made in two crosscuts from 2,040-ft. point of big tunnel, and it is expected that in about 40 days one of the large veins will be cut. Central, Park and Idanah veins will be intercepted by two crosscuts. A 10-ft. cross vein has been cut, and samples from it assay 1.6% copper, 2 oz. of silver and 23% zinc. Showing indicates that crosscut is approaching mineral zone and that values go down. The 10-ft. vein does not outcrop on surface, and is one of several such blind veins that have been encountered in big tunnel. Developments are confirming report and predictions made by Walter Harvey Weed, who made an exhaustive examination of the Boston & Montana properties and recently issued a supplementary report on them.

NEVADA

Storey County

COMSTOCK PUMPING ASSOCIATION (Virginia)—Enlarged drain and laid floor and track 174 ft. in old north drift on 2,700 level.

CROWN POINT-BELCHER (Gold Hill)—New pump started on 1,500 joint station. Water held at 125-ft. point below 1,500 station. Belcher 1,300 raise advanced 30 ft. and 86 cars of mill rock saved.

MEXICAN (Virginia)—On 2,700 level, east crosscut No. 3 shows porphyry and quartz of low assay value. On 2,500 level south drift, Nos. 3 and 4 from west crosscut extended through similar formation. Mill crushed 61 tons of Union ore assaying $7.92 per ton, and 83 tons of Mexican wedge rock.

UNION CON. (Virginia)—On 2,500 level extracted 12 cars of ore averaging $39.28 per ton, and from southwest drift 4 cars averaging $38.75 per ton. Saved 45 cars low-grade ore in cutting out for timbers in north drift. Joint work with Sierra Nevada in 2,450 raise and reopening southwest drift to Union shaft continued.

CON. VIRGINIA AND OPHIR (Virginia)—Preparations being made for operating on 2,700 level. On 2,500 level in Ophir, raise made to third floor on the vein in southwest drift. Saved 14 cars of ore assaying $9.23 per ton. In Central tunnel, north drift extended 16 ft. Quartz in bottom assays from small amounts up to $10 per ton. Ophir saved 320 cars of ore from development and milled 275 tons.

SOUTH DAKOTA

Lawrence County

NORTH HOMESTAKE (Maitland)—One shift of miners is employed in development work on 600 level of main shaft.

ORO HONDO (Lead)—Shaft is 1,700 ft. deep. Crosscutting is under way both easterly and westerly from 1,500 level. Rock continues hard in bottom.

GOLDEN REWARD (Deadwood)—Astoria roaster is being operated steadily, principally upon blue ores from Billy mine. About 75 tons daily being thus prepared for cyanidation. Deadwood mill makes 90% extraction on roasted product.

UTAH

Beaver County

LEONORA (Milford)—Drifting along east-west fissure is being continued, and it is expected that north-south fissure will be cut soon. Former fissure, which carries silver-lead ore, is growing wider.

PALOMA GOLD AND SILVER (Milford)—Progress of about a foot a day is being made in shaft sinking. Better progress will be made when compressor is installed early in October. Shaft is still in ore. Shipment of copper ore of good grade was made recently; also shipments of lead-silver ore.

Salt Lake County

OHIO COPPER (Bingham)—Mill at Lark is now treating 2,000 tons of ore daily.

WASATCH MINES (Alta)—High-grade shipment of silver-lead ore has been made from No. 2 workings on Brain fissure.

LOGGER MINING (Salt Lake)—Stringers of galena have been cut in face of this company's tunnel. Property is in Big Cottonwood. J. A. Maxfield is president.

PRICE MINING (Salt Lake)—Two-story bunk-house is being built for better accommodation of men at this property in Big Cottonwood.

MONTANA-BINGHAM (Bingham)—Tunnel is in 4,048 ft., face being in quartzite. Number of viens have been cut. Last fissure carried 2 ft. of pyritic ore, showing chalcopyrite and black copper sulphide.

AMERICAN CONSOLIDATED COPPER (Salt Lake)—Stock of this company, owning 16 claims in Big Cottonwood, was listed on Salt Lake Stock and Mining Exchange on Sept. 14. Capitalization is 500,000 shares, par value, $1. John E. Barnard is president.

Summit County

PARK CITY ORE PRODUCTION for week ended Sept. 18 totaled 1,727 tons, valued at $68,000, compared with 1,425 tons week previous. Four shippers.

SNAKE CREEK TUNNEL (Park City)—Tunnel is in more than 12,200 ft., with face still in diorite. Ground is getting softer, and flow of water is increasing.

NAILDRIVER (Park City)—An assessment of 2c. a share has been levied, and it is expected that development work will be started shortly. Pipe-line is being laid, and surface equipment put in order.

DALY-JUDGE (Park City)—Building for new flotation plant is in process of construction. Shipments for week ended Sept. 18, amounted to 1,133,650 lb. of ore and concentrates. Development is being kept up, and new orebodies opened.

WASHINGTON

Ferry County

KNOB HILL (Republic, Wash.)—Car of 75,299 lb. of ore sent to Trail smeltery yielded 2.4 oz. gold and 7.2 oz. silver per ton. Gross value was $1,837 and net profit was $1,545. "There are nine cars now en route to the smelter that probably will run about the same," states Mr. LaRue, a heavy stockholder. "The net earnings for August are estimated at $12,000, and the average monthly profit for the current year probably will be not less than $10,000."

King County

ANTIMONY SMELTING AND REFINING CO. (Seattle)—This company, with a capital of $200,000, has been formed by W. D. Wood and H. M. Grifith, who have taken over the sewer-pipe manufacturing plant of the Denny-Renton Clay Co., at Van Asselt, and will convert same into a smeltery for the treatment of antimony ores. The plant covers several acres and has fifteen 30-ft. furnaces with several smaller furnaces, an ore-grinding plant and laboratories.

WISCONSIN

Zinc-Lead District

ZINC HILL (Platteville)—Charles Wolfe and associates of Davenport, Iowa, have struck good ore in number of drill holes on Charles Harris and Felix Murphy farms, four miles south of Platteville.

VINEGAR HILL ZINC (Platteville)—Plans are made for big surface equipment on Blackstone property adjacent to Champion mine at New Diggings.

GRANT COUNTY (Platteville)—Kistler and Stephens have encountered big body of zinc ore in heavy sheet formation in old workings just unwatered.

POWDER MILL (Platteville)—Fritz Hoppe and others are developing promising prospect on old Powder Mill tract just west of city limits of Platteville. Ore was found at shallow depth of 14 ft. Makes in disseminated formation and will turn out high-grade zinc concentrate.

CANADA

Ontario

ORE SHIPMENTS over the T. & N. O. Ry. for the month of August, 1915, from Cobalt proper were: Chambers Ferland, 29 tons; Cobalt Comet, 64; Coniagas, 78; Crown-Reserve, 99; Kerr Lake, 57; La Rose, 131; McKinley-Darragh, 114; Mining Corporation of Canada, Ltd., Cobalt Lake mine, 86.20 and Townsite City, 138.62; Nipissing, 65; O'Brien, 32; Penn Canadian, 69; Peterson Lake—Seneca Superior ore, 65; Temiskaming, 41; from New Liskeard, Casey Cobalt, 39; from Elk Lake, Miller Lake O'Brien, 24; total silver ore shipments, 1,131 tons. From South Porcupine, Dome Lake (gold), 31 tons; from Schumacher, Porcupine Vipond (gold), 1 ton; from Porquis Junction, Alexo mine, (nickel), 767 tons.

CUBA

McLAUGHLIN BROS. (Bayamo)—Have discontinued work on their matte-smelting plant on account of excessively rainy season.

The Market Report

Metal Markets

NEW YORK—Sept. 29

All of the principal metals were stronger during the last week, with the exception of tin, which was dull and stationary.

Copper, Tin, Lead and Zinc

Copper—The improvement noted in our last report continued and at the beginning of our week of record, sales began to be made more freely at 18c., regular terms, equivalent to about 17.80c., cash, New York, although there was a little shading of that price in some quarters. It was noteworthy, moreover, that the buyers were now principally domestic manufacturers, whereas in the previous week the sales had been chiefly for export. By Sept. 25, the principal producer had sold all it wanted to at 18c., regular terms, and then it raised its asking price to 18¼c., expecting the market to rise to that figure, which, however, has not yet transpired. On Sept. 27, the market was rather irregular, considerable sales being made at a variety of prices ranging from 17.95c. to 18⅛c., both regular terms. Apparently the market had not become firmly established on the 18c. basis, although more than one of the large producers had raised their asking price to 18¼c., and some sales were actually made as high as 18⅛c. Perceiving this situation, other sellers apparently became more liberal in their offers to furnish supplies at 18c., and at the close a good deal of copper was still available at that price.

Sales for export were made right through the week at £86½@87, c.i.f., London, Havre, etc.

The buying in this market was chiefly by domestic brass makers. There seemed to be rather more inquiry for wire bars. On the other hand, the demand for cakes was rather light, the business of the rolling mills still being slack. The striking feature of the domestic copper buying last week was that the consumers did not exhibit the signs of acting in concert that they have upon previous occasions. The aggregate of the transactions during the week was fair, but the total did not attain any such proportions as to excite special comment.

Some relatively cheap copper appears to be available as the result of arbitrage transactions between prompt and future deliveries. Purchasers of such copper for prompt delivery are naturally willing to sell it at a slight advance. Some profitable business also appears to be done in sales of refined against purchases of crude copper from foreign sources.

Copper Sheets are quoted about 23c. per lb. for hot rolled and 24c. for cold rolled, with usual extras. Wire prices are unsettled; quotations may be put at 19½c. per lb. at mill. The chief maker does not quote base price.

Tin—The market was very quiet with but slight changes of price. The deliveries in September have been very large and the opinion is expressed in the trade that the market is becoming overstocked.

Lead—Good business was done right through the week, and it was anticipated in several quarters that the A. S. & R. Co. would advance its price. It did not do so, but continued to sell freely at 4½c., New York. Its competitors supplied their regular customers with lead at that price but some of them seemed to be averse to selling anything they did not have to. One large producer sold out its October production, and on Sept. 28 began to talk about 4.75c. In the St. Louis market, the price advanced right through the week, and toward the close became established at the list price of the A. S. & R. Co., which is above the ordinary differential. Some sales of lead for export were made.

Spelter—This market has worked itself into a more peculiar position than ever. A rather large tonnage was sold during the week and the curious thing is that this was mostly for delivery in the first quarter of 1916, while there was but relatively little business done for prompt delivery or for deliveries anywhere during the last quarter of 1915. Considering the latter as the market for ordinary contracts, prices ranged from 13@14c. in the latter part of the week, which was a slight advance from the beginning. Business done for the first quarter of 1916 was at prices from 10½@11½c. The orders for this spelter came from abroad. But little domestic business was done during the whole week. Indeed, consumers might be characterized as apathetic. On the other hand, producers evinced no eagerness to sell, although the supplies available are not, perhaps, so small as is represented.

Rapid progress is being made at Donora. The pottery is now in operation and it is expected that spelter will be produced before the middle of October.

Exports from Baltimore for the past week included 394,384 lb. zinc dross and skimmings to Liverpool. Imports at Baltimore included 4,422 tons zinc concentrates from Port Pirie, Australia.

Zinc Sheets—Business has been active, and sales good. Prices are unchanged. The base price for carload lots is $16 per 100 lb. f.o.b. Peru, Ill., less 8% discount.

DAILY PRICES OF METALS IN NEW YORK

Sept.	Sterling Exchange	Silver, Cts. per Oz.	Copper	Tin	Lead		Zinc
			Electrolytic, Cts. per Lb.	Spot, Cts. per Lb.	New York, Cts. per Lb.	St. Louis, Cts. per Lb.	St. Louis, Cts. per Lb.
23	4.7125	49⅛	17.60 @17.80	32¼	4.50	4.35 @4.42½	12.75 @13.50
24	4.7050	49⅛	17.70 @17.80	32½	4.50	4.35 @4.42½	13.00 @13.75
25	4.7075	49⅛	17.70 @17.90	32½	4.50	4.37½ @4.42½	13.00 @13.75
27	4.7063	49⅛	17.80 @17.90	33	4.50	4.40 @4.42½	13.00 @14.00
28	4.7050	49⅛	17.80 @17.85	33¼	4.50	4.42½	13.00 @14.00
29	4.7200	49⅛	17.80 @17.85	33	4.50	4.42½	13.00 @14.00

The quotations herein are our appraisal of the average markets for copper, lead, spelter and tin based on wholesale contracts for the ordinary deliveries of the trade as made by producers and agencies; and represent, to the best of our judgment, the prevailing values of the metals, reduced to basis of New York, cash, except where St. Louis is given as the basing point. St. Louis and New York are normally quoted 0.17c. apart.

The quotations for electrolytic copper are for cakes, ingots and wirebars. Electrolytic copper is commonly sold at prices including delivery to the consumers and is subject to discounts, etc. The price quoted for copper on "regular terms" is the gross price including freight to the buyer's works and is subject to a discount for cash. The difference between the price delivered and the New York cash equivalent is at present about 0.20c. on domestic business. The price of electrolytic cathodes is 0.05 to 0.10c. below that of electrolytic. Quotations for lead represent wholesale transactions in the open market for good ordinary brands. Quotations for spelter are for ordinary Prime Western brands. Only the St. Louis price is herein quoted, St. Louis being the basing market. We quote the New York price at 17c. per 100 lb. above the St. Louis price.

Silver quotations are in cents per troy ounce of fine silver.

Some current freight rates on metals per 100 lb. are; St. Louis-New York 17c.; St. Louis-Chicago, 6.5c.; St. Louis-Pittsburgh, 13.1c.

LONDON

Sept.	Silver	Copper				Tin		Lead		Zinc	
		Standard		Electrolytic							
		Spot	3 Mos.	£ per Ton	Cts. per Lb.	Spot	3 Mos.	£ per Ton	Cts. per Lb.	£ per Ton	Cts. per Lb.
23	23⅛	69⅝	70⅛	87	18.30	150	150¾	23½	4.94	63	13.25
24	23⅛	69⅜	70⅜	87	18.27	151½	152	23⅛	4.96	63	13.22
25	23⅛	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
27	23⅛	70⅛	71⅛	87½	18.38	152½	153	23⅛	4.99	63	13.23
28	23⅛	71	72	87½	18.37	153¼	154	23⅛	4.98	63	13.22
29	23 11/16	71¼	72¼	87½	18.44	153	154	23¾	5.00	63	13.27

The above table gives the closing quotations on London Metal Exchange. All prices are in pounds sterling per ton of 2240 lb., except silver which is in pence per troy ounce of sterling silver, 0.925 fine. Copper quotations are for standard copper, spot and three months, and for electrolytic, price for the latter being subject to 3 per cent. discount. For convenience in comparison of London prices, in pounds sterling per 2240 lb., with American prices in cents per pound the following approximate ratios are given, reckoning exchange at 4.80. £15 = 3.21c.; £20 = 4.29c.; £30 = 6.43c.; £40 = 8.57c.; £60 = 12.85c. Variations, £1 = 0.21⅜c.

Other Metals

NEW YORK—Sept. 29

Aluminum—Spot supplies are still scarce and prices firm. Sales of No. 1 ingots have been made at 47@50c. per lb. The American manufacturer has not advanced its prices, nominally, but is unable to make deliveries on new business for several months.

Antimony—The market has been quiet, with only the usual small jobbing trade, and no large business reported. Chinese and other ordinary brands are quoted at 28@29c. per lb.; while 43@45c. is asked for Cookson's.

Nickel—Quotations for ordinary forms are 45@50c. per lb., according to size and terms of order. A premium of 3c. per lb. is charged for electrolytic nickel.

Quicksilver—The market is firmer, demand being good and stocks only moderate. New York quotations are $89 per flask of 75 lb. for large lots; $90 for smaller orders. San Francisco reports by telegraph a firm market at $87.50@90 per flask. London price is £16 per flask, with no discount from second hands.

Minor Metals—Current quotations for **Bismuth** are $3 per lb., New York.—**Cadmium** is quoted at 7s. per lb. in London; $1.75@1.90 per lb., New York.—**Chromium** metal, 75c. per lb., New York.—**Cobalt** metal, 97% pure is sold at $2 per lb.—**Magnesium,** pure, has gone to a high price, $6 per lb. being asked.—**Selenium** varies from $2.50@3 per lb., New York, for large lots; $4.50@5 for retail quantities.—**Tellurium** is quoted at 80s. per lb. in London.

Gold, Silver and Platinum

NEW YORK—Sept. 29

Gold and Silver Movement in the United States eight months ended Aug. 31 as reported by the Department of Commerce:

	Gold		Silver	
	1914	1915	1914	1915
Exports.....	$135,769,576	$10,902,690	$33,090,463	$32,195,543
Imports.....	37,180,356	223,796,660	15,927,273	22,489,419
Excess.....	E.$98,589,220	I. $212,893,970	E. $17,163,190	E. $9,706,124

Exports of merchandise for the eight months are valued at $2,232,758,886; imports at $1,150,784,196; excess of exports, $1,081,974,690. Adding the gold and silver gives $878,786,844 as the net export balance.

Iridium—This metal is in rather short supply and prices are at a high level. About $75@80 per oz. is quoted nominally, but purchases are subject to negotiation.

Platinum—Prices remain high and irregular, and transactions have not been large. The market is uneasy and the future depends largely upon the possibility of new imports. Dealers ask $50@54 per oz. for refined platinum, while $56@58 per oz. is quoted for hard metal.

Silver has been steady for several days at 23⅝ to 23¾d. The tone of the market continues good. It is to be noted, however, that recently Indian orders have not come to London, and it is probable that they have been filled from China, as the stock in Bombay has increased.

Zinc and Lead Ore Markets

JOPLIN, MO.—Sept. 25

Blende, high price, $82.80; base per ton 60% zinc, premium ore, $80; medium, $79@77; lower, $75@73, with a few lots at $70, in car lots, while ton lots sold at $65; calamine base 40% zinc, car lots, $65@55, and ton lots down to $45; average, all grades of zinc, $75.82 per ton. Lead, high price, $55.50; base, $55@50 per ton 80% metal content; average all grades of lead, $49.34 per ton.

SHIPMENTS WEEK ENDED SEPT 25

	Blende	Calamine	Lead	Values
Totals this week..	14,299,430	267,390	1,939,530	$600,090
Totals 9 months..	420,706,110	42,934,680	65,341,640	18,455,190

Blende value, the week, $544,750; 9 months, $15,989,820.
Calamine value, the week, $7,510; 9 months, $747,770.
Lead value, the week, $47,830; 9 months, $1,717,600.

PLATTEVILLE, WIS.—Sept. 25

The base price paid this week for 60% zinc ore was $70@72 per ton, down to $65 per ton bid for medium grades. No sales of lead ore were reported.

SHIPMENTS, WEEK ENDED SEPT. 25

	Zinc Ore, Lb.	Lead Ore, Lb.	Sulphur Ore, Lb.
Week	4,869,480	.....	379,400
Year	143,511,600	4,543,160	20,020,310

Shipped during week to separating plants, 4,418,700 lb. zinc ore.

Iron Trade Review

NEW YORK—Sept. 29

The market continues strong and active, with but little change. It is largely dependent on export business, though domestic trade is improving.

The pig-iron market is in good condition and demand is heavy for basic pig. Foundry iron is a little slower, especially for 1916 business.

The greatest sensation in the trade is the purchase of the Midvale Steel Works by a syndicate of which W. E. Corey, formerly president of the Steel Corporation, is head, and in which Standard Oil interests are reported to be prominent. The transfer has been made by the purchase of the stock, which was owned chiefly by Charles J. Harrah and the Sellers family. The purchase was made through Philadelphia bankers, the reported price being $185 per share.

The Midvale plant is at Nicetown, Philadelphia, and covers about 52 acres. The company's latest balance sheet valued this plant at $11,743,782 and showed total assets of $15,551,504. The business dates back to 1866. The Midvale is one of the three armorplate manufacturing companies in the United States. It also makes ordnance, heavy steel forgings and locomotive tires. About 5,500 men are employed now, the works running to capacity. The new owners, it is understood, will increase the capital and enlarge the works.

This transaction has started up again the talk about the sale of the Cambria and the Pennsylvania steel works and the possibility of a new combination. Thus far, however, this is mainly in the air and there is nothing definite known.

PITTSBURGH—Sept. 28

The volume of steel business has increased in the past week. Domestic consuming industries generally are increasing their specifications, and the railroads are actively in the market. They have made fairly large purchases of bars and plates for their car repair shops, and of plates and shapes for their fitting shops, while rail orders are being placed freely and there is heavier inquiry for cars. The New York Central lines have bought 2,500 cars for two divisions and are expected to buy shortly for other divisions.

Demand for war material seems still to be increasing, inquiry being particularly heavy for large forging billets, for making large shells. Another advance in wire prices is expected shortly, following that of Sept. 20, on account of the heavy export movement. Steel exports to neutral countries are now increasing sharply, having thus far been below the average for normally good times. Steel prices are advancing.

Pig Iron—Price advances seem to have halted. The steel mills are not actively in the market, while foundries are covered for this year and are showing little interest in next year's deliveries. Prices are firm but are not advancing and the fact that several idle furnaces would get into blast if they could sell a backlog of tonnage is probably assuring consumers that there will be no runaway market at any early date. In some quarters a general buying movement for first half is predicted before the middle of November. We quote: Bessemer, $16; basic, $15; foundry and malleable, $14.50@15; forge, $14.25@14.75, f.o.b. Valley furnaces, 95c. higher delivered Pittsburgh.

Steel—There is heavy inquiry for large forging billets and fairly insistent inquiry for rolling billets, sheet bars being neglected. Sellers are not making regular quotations. Openhearth billets are all of $26, Youngstown, with bessemer about $1 less, while prices delivered Pittsburgh are 50c.@$1 above Youngstown.

COKE

Connellsville—Spot furnace coke has advanced 10c. to $1.75 @1.80, on account of decreased offerings rather than heavier buying. Negotiations on first-half contracts seem nearer the closing stage, minimum prices being between $1.75 and $2. Operators would quote flat prices of $2.40 or $2.50 but the sliding-scale basis seems to be preferred by both buyers and sellers.

Chemicals

NEW YORK—Sept. 29

The general markets are fairly active, and seem rather steadier than they have been.

Arsenic—The market is quiet and unchanged. Prices are $3.50 per 100 lb. for large lots, and up to $4 for smaller orders.

Copper Sulphate—Business is fairly steady and sales moderate. Quotations are $6.75 per 100 lb. for carload lots and $7 per 100 lb. for smaller parcels.

Nitrate of Soda—There is no change of importance in this market. Prices continue about 2.42½c. per lb. for spot and 2.45c. for futures.

Assessments

Company	Delinqe	Sale	Amt.
Bonanza Con., Utah	Sept. 15	Oct. 6	$0.015
Buffalo, Mont	Sept. 10	Oct. 10	0.003
Cash Boy, Nev	Sept. 29	Oct. 30	0.01
Coeur d'Alene, Ida	Sept. 14	Oct. 14	0.002
Columbus Ext., Utah	Oct. 10	Oct. 30	0.025
Comstock, Ida	Sept. 30	Oct. 30	0.001
Con. Virginia, Nev	Sept. 28	Oct. 19	0.05
Diam'field Black Butte, Nev.	Oct. 4	Nov. 4	0.01
E. Hercules Ext., Ida. (post.)	.....	Oct. 11	0.0015
Exchequer, Nev	Oct. 4	Oct. 25	0.02
Four Timbers, Wash	Oct. 4	Nov. 4	0.001
Gethin Le Roy, Utah	Sept. 25	Oct. 13	0.01
Giant M. & D., Ida	Oct. 7	Nov. 8	0.003
Goldstrike M. & L., Utah	Oct. 1	Oct. 20	0.01
Great Bend, Nev	Sept. 10	Oct. 10	0.01
Hancock Cons., Mich	Sept. 1	.....	1.00
Hancock Cons., Mich	Jan. 3	.....	1.00
Hector, Ida	Sept. 4	Oct. 4	0.005
Idaho Nevada, Ida	Sept. 7	Oct. 1	0.002
Idora, Ida	Oct. 11	Nov. 11	0.005
Imperial, Ida	Aug. 31	Oct. 1	0.005
Keweenaw, Mich	Sept. 1	.....	1.00
Lake Superior & West., Ariz.	.....	.....	0.02
LeRoy, Ida	Sept. 25	Oct. 25	0.002
M. & P. Gold, Utah	Sept. 15	Oct. 12	0.0025
Mount Pleasant Con., Calif.	.....	Oct. 7	0.08
Nalldriver, Utah	Oct. 9	Nov. 8	0.02
Nevada Cooperative, Nev	Sept. 15	Oct. 15	0.01
Nevada-Douglas, Nev	Sept. 27	Oct. 20	0.10
New Arcadian, Mich	Dec. 1	.....	0.50
New Baltic, Mich	Jan. 15	.....	0.50
New Quincy, Utah	Sept. 2	Sept. 23	0.01
Northern Light, Ida	Nov. 2	Dec. 2	0.004
Oom Paul Con, Ida	Aug. 30	Oct. 4	0.01
Ophir, Nev	Oct. 12	Nov. 2	0.05
Phedora, Ida	Sept. 21	Oct. 21	0.0005
Phoenix, Mich	Sept. 1	.....	1.00
Phoenix, Mich	Jan. 1	.....	1.00
Pioche Metals, Nev	Oct. 20	Nov. 20	0.00½
Rainbow, Ida	Oct. 15	Nov. 20	0.002
Revelator, Utah	Oct. 4	Oct. 25	0.00½
Rockford, Ida	Oct. 4	Oct. 30	0.005
Royal, Ida	Sept. 1	Oct. 1	0.001
Silver Moon, Ida	Oct. 15	Nov. 18	0.005
Silver Pick Cons., Nev	Oct. 16	Nov. 23	0.01
Snowstorm Ext	Sept. 16	Oct. 18	0.003
Sunset M. & D., Nev	Oct. 18	Nov. 22	0.02
Sunshine, Ida	Oct. 15	Nov. 15	0.0006
Syndicate, Utah	Sept. 11	Oct. 2	0.001
Temple, Ida	Sept. 20	Oct. 20	0.002
Tonopah Bonanza, Nev	Sept. 13	Oct. 11	0.01

Stock Quotations

Among sales at auction on Sept. 22 in New York City was 5,000 San Toy Mining, par value $1, at 15c. each.

COLO. SPRINGS	Sept. 28	SALT LAKE	Sept. 28
Name of Comp.	Bid.	Name of Comp.	Bid.
Acacia	.02½	Beck Tunnel	.06
Cripple Cr'k Con.	.008	Black Jack	.05
C. K. & N.	.02	Colorado Mining	.08½
Doctor Jack Pot	.09	Crown Point	.01½
Elkton Con.	.24½	Daly-Judge	6.60
El Paso	.75	Emma Cop.	.28
Findlay	.04	Gold Chain	.16
Gold Dollar	.01	Grand Central	.54
Gold Sovereign	.03½	Iron Blossom	.72
Golden Cycle	1.79½	Little Bell	‡.10
Isabella	.16½	Lower Mammoth	.00½
Jack Pot	.06½	May Day	.16½
Jennie Sample	‡.02	Opohongo	.00½
Jerry Johnson	.04	Prince Con	.62
Lexington	.005	Seven Troughs	.01
Mary McKinney	.37	Silver King Coal'n	3.30
Pharmacist	.008	Silver King Con.	2.00
Portland	1.54	Sioux Con.	.01½
Raven B. H.	.03½	Uncle Sam	.04
Vindicator	1.54	Yankee	.33

TORONTO	Sept. 28		
Bailey	.05	Dome Exten	.27
Conlagas	4.00	Foley O'Brien	.30
Peterson Lake	.22	Hollinger	25.00
Right of Way	.04	Imperial	.05
Seneca Superior	‡.78	Jupiter	.12
Silver Queen	‡.01	McIntyre	.49
T. & Hudson Bay	20.00	Pearl Lake	‡.00½
Timiskaming	.37	Porcu. Crown	.73
Wettlaufer-Lor	.07	Preston E. D.	.04½
Dome Mines	22.37½	Rea	‡.09

SAN FRANCISCO	Sept. 28		
Comstock Stocks		Misc. Nev. & Cal	
Alta	‡.05	Belmont	3.50
Andes	.07	Jim Butler	.78
Best & Belcher	.05	Lone Star	.05
Caledonia	.52	MacNamara	.02
Challenge Con	.04	Midway	.11
Chollar	.03	Mont.-Tonopah	.30
Confidence	.16	North Star	.11
Con. Virginia	.13	Rescue Eula	.10
Gould & Curry	.03	West End Con	.59
Hale & Norcross	.03	Atlanta	.29
Jacket-Cr. Pt	.13	Booth	.44
Julia	‡.03	C.O.D. Con	.04
Mexican	.32	Comb. Frac	.09
Occidental	.79	D'field Daisy	.04
Ophir	.18	Jumbo Extension	1.30
Overman	.07	Pitts.-Silver Peak	.07
Potosi	.04	Round Mountain	.40
Savage	.04	Sandstorm Kendall	.12
Sierra Nevada	.19	Silver Pick	.07
Union Con	.34	Central Eureka	.12

N. Y. EXCH.	Sept. 28	BOSTON EXCH	Sept. 28
Name of Comp.	Clg.	Name of Comp.	Clg.
Am.Sm.&Ref.,com	86½	Adventure	1½
Am. Sm. & Ref., pf.	108½	Ahmeek	399½
Am. Sm. Sec., pf. B.	80½	Alaska Gold M	32½
Anaconda	73⅝	Algomah	2½
Batopilas Min	1½	Allouez	55½
Bethlehem Steel	365	Am. Zinc	55
Bethlehem Steel, pf.	165	Ariz. Com., ctfs.	8½
Chino	45½	Bonanza	.35
Colo. Fuel & Iron	62½	Butte-Balaklava	3⅛
Crucible Steel	101½	Butte & Superior	60
Federal M. & S., pf.	47	Calumet & Ariz.	62½
Great Nor., ore., ctf.	48½	Calumet & Hecla	550
Guggen. Exp.	66½	Centennial	18
Homestake	118	Copper Range	55½
Inspiration Con	37½	Daly West	12
International Nickel	214	East Butte	12½
Mex. Petroleum	89	Franklin	9
Miami Copper	28	Granby	85½
Nat'l Lead, com	66½	Hancock	17½
National Lead, pf.	110½	Hedley	27
Nev. Consol.	14½	Helvetia	.30
Ontario Min	3½	Indiana	5½
Quicksilver	‡2½	Island Cr'k, com	45
Ray Con	22½	Island Cr'k, pfd.	88½
Republic I&S, com.	53½	Isle Royale	28
Republic I&S, pf.	103½	Keweenaw	2⅛
SlossSheff'd, com	57	Lake	13⅞
Tennessee Copper	60⅛	La Salle	5½
Utah Copper	68½	Mason Valley	1½
U. S. Steel, com	78½	Mass	11
U. S. Steel, pf.	114½	Mayflower	4½
		Michigan	2⅛
N. Y. CURB	Sept. 28	Mohawk	74
Alaska Juneau	11½	New Arcadian	10
Alta Con	.31	North Butte	30
Beaver Con	.28	North Lake	1½
Big Four	.05	Ojibway	1½
Blue Bell	.03	Old Colony	3⅛
Braden Copper	9½	Old Dominion	53
Buffalo Mines	.75	Osceola	84½
Can. Cop. Corpn	‡⅞	Quincy	82
Cashboy	.04½	Santa Fe	3⅛
Chambers Ferland	.13	Shannon	7
Chile Cop.	19	Shattuck-Ariz	27½
Con. Ariz. Sm.	1 1/16	Superior	27
Con. Coppermines	1½	Superior & Bost	2⅛
Con. Nev.-Utah	.25	Tamarack	56½
Dia. Black B.	.07½	Trinity	4½
Florence	.50	Tuolumne	.44
Goldfield Con.	1 11/16	U. S. Smelting	41
Goldfield Merger	.19	U. S. Smelt'g, pf.	47
Greene Cananea	39	Utah Apex	3½
Kennecott Cop.	53½	Utah Con	12½
Kerr Lake	3 7/16	Victoria	2½
La Rose		Winona	3
Magma	14⅛	Wolverine	58½
McKinley-Dar-Sa	.25	Wyandot	1½
Mines of Am	2		
Nevada Hills	.18	BOSTON CURB	Sept. 28
New Utah Bingham	3⅛	Bingham Mines	7½
Nipissing Mines	7½	Boston Ely	.22
Oro	.07	Butte & Lon'n Dev.	.30
St. Joseph Lead	12½	Calaveras	1⅛
South Utah	.15	Calumet-Corbin	.04
Stand'd Oil of N.J.	500	Chief Con	.88
Standard S. L.	1 9/16	Cortez	.42
Stewart	11/16	Crown Reserve	.37
Success	.86	Davis-Daly	1⅛
Tonopah	5⅛	Eagle & Blue Bell	1⅛
Tonopah Ex.	2 7/16	First Nat. Cop.	2⅛
Tonopah Merger	.33	Houghton Copper	2½
Tribullion	.25	Iron Cap Cop., pf.	5
Tularosa	‡⅛	Majestic	.67
Yukon Gold	2⅛	Mexican Metals	.21
		Nevada-Douglas	.75
LONDON	Sept. 15	New Baltic	2⅛
Alaska Tre'dwell	£6 12s 6d	New Cornelia	9
Burma Corp.	1 13 1½	Ohio Copper	.08
Cam & Motor	0 12 9	Oneco	.50
Camp Bird	0 4 9	Raven Copper	.10
El Oro	0 7 0	Rex Cons	.51
Esperanza	0 7 3	Smokey Dev	.15
Mexico Mines	3 11 3	So. Lake	5½
Nechi, pfd.	0 12 6	Tonopah Victor	.28
Oroville	0 14 9	Trethewey	.14
Santa Gert'dis	0 7 6	United Verde Ext.	5½
Tomboy	1 0 3		
Tough Oakes	0 6 6	‡Last Quotations.	

Monthly Average Prices of Metals

SILVER

Month	New York			London		
	1913	1914	1915	1913	1914	1915
January	62.938	57.572	48.855	28.983	26.553	22.731
February	61.642	57.506	48.477	28.357	26.573	22.753
March	57.870	58.067	50.241	26.669	26.788	23.708
April	59.490	58.519	50.250	27.416	26.958	23.709
May	60.361	58.175	49.915	27.825	26.704	23.570
June	58.990	56.471	49.034	27.199	25.948	23.267
July	58.721	54.678	47.519	27.074	25.219	22.597
August	59.293	54.344	47.163	27.335	25.979	22.780
September	60.640	53.290	.....	27.986	24.260	.....
October	60.793	50.654	.....	28.083	23.199	.....
November	58.995	49.082	.....	27.263	22.703	.....
December	57.760	49.375	.....	26.720	22.900	.....
Year	59.791	54.811	.....	27.576	25.314	.....

New York quotations cents per ounce troy, fine silver; London, pence per ounce, sterling silver, 0.925 fine.

COPPER

Month	New York		London			
	Electrolytic		Standard		Best Selected	
	1914	1915	1914	1915	1914	1915
January	14.223	13.641	64.304	60.756	69.488	65.719
February	14.491	14.394	65.259	63.494	70.188	*
March	14.131	14.787	64.276	66.152	69.170	*
April	14.211	16.811	64.747	75.096	69.313	*
May	13.996	18.506	63.182	77.600	67.786	*
June	13.603	19.477	61.336	82.574	66.274	95.333
July	13.223	18.796	60.540	76.011	64.955	91.409
August	*	16.941	‡	68.673	‡	82.333
September	*	.....	‡	.....	‡	.....
October	*	.....	‡	.....	‡	.....
November	11.739	.....	53.227	.....	*	.....
December	12.801	.....	56.841	.....	*	.....
Year	.....	.....	.....	.....	.....	.....

TIN

Month	New York		London	
	1914	1915	1914	1915
January	37.779	34.260	171.905	156.550
February	39.830	37.415	181.556	176.925
March	38.038	48.426	173.619	180.141
April	36.154	47.884	163.963	166.225
May	33.360	38.790	150.702	162.675
June	30.577	40.288	138.321	167.636
July	31.707	37.423	142.517	167.080
August	*	34.389	‡	151.440
September	32.675	.....	‡	.....
October	30.284	.....	‡	.....
November	33.304	.....	139.391	.....
December	33.601	.....	147.102	.....
Av. year	34.301	.....	.....	.....

LEAD

Month	New York		St. Louis		London	
	1914	1915	1914	1915	1914	1915
January	4.111	3.729	4.011	3.548	19.665	18.606
February	4.048	3.827	3.937	3.718	19.606	19.122
March	3.970	4.053	3.850	3.997	19.651	21.883
April	3.810	4.221	3.688	4.142	18.225	21.094
May	3.900	4.274	3.808	4.182	18.503	20.347
June	3.900	5.932	3.810	5.836	19.411	25.170
July	3.891	5.659	3.738	5.531	19.051	24.611
August	3.875	4.656	3.715	4.520	‡	21.946
September	3.828	.....	3.658	.....	‡	.....
October	3.528	.....	3.384	.....	‡	.....
November	3.683	.....	3.585	.....	18.500	.....
December	3.800	.....	3.662	.....	19.097	.....
Year	3.862	.....	3.737	.....	.....	.....

SPELTER

Month	New York		St. Louis		London	
	1914	1915	1914	1915	1914	1915
January	5.262	6.386	5.112	6.211	21.533	30.844
February	5.377	8.436	5.228	8.255	21.413	39.819
March	5.250	8.541	5.100	8.366	21.460	44.141
April	5.113	10.012	4.963	9.837	21.560	49.888
May	5.074	14.781	4.924	14.610	21.393	68.100
June	5.000	21.208	4.850	21.038	21.345	100.614
July	4.920	19.026	4.770	18.856	21.568	97.250
August	5.568	12.781	5.418	12.611	‡	67.786
September	5.380	.....	5.230	.....	‡	.....
October	4.909	.....	4.750	.....	‡	.....
November	5.112	.....	4.962	.....	25.016	.....
December	5.592	.....	5.430	.....	27.369	.....
Year	5.213	.....	5.061	.....	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton. * Not reported, ‡ London Exchange closed.

PIG IRON IN PITTSBURGH

Month	Bessemer		Basic		No. 2 Foundry	
	1914	1915	1914	1915	1914	1915
January	$14.94	$14.59	$13.23	$13.45	$13.99	$13.90
February	15.06	14.55	14.12	13.45	14.08	13.90
March	15.07	14.55	13.91	13.45	14.10	13.95
April	14.90	14.55	13.90	13.45	14.13	13.95
May	14.90	14.61	13.90	13.60	14.27	13.83
June	14.90	14.70	13.90	13.67	13.96	13.77
July	14.90	14.94	13.90	13.91	13.90	13.68
August	14.90	16.01	13.90	15.31	14.08	14.75
September	14.90	.....	13.90	.....	14.03	.....
October	14.84	.....	13.75	.....	13.97	.....
November	14.59	.....	13.43	.....	13.83	.....
December	14.70	.....	13.45	.....	13.83	.....
Year	$14.88	.....	$13.78	.....	$14.01	.....

The Mining Index

This index is a convenient reference to the current literature of mining and metallurgy published in all of the important periodicals of the world. We will furnish a copy of any article (if in print) in the original language for the price quoted. Where no price is quoted, the cost is unknown. Inasmuch as the papers must be ordered from the publishers, there will be some delay for foreign papers. Remittance must be sent with order. Coupons are furnished at the following prices: 20c. each, six for $1, 33 for $5, and 100 for $15. When remittances are made in even dollars, we will return the excess over an order in coupons, if so requested.

COPPER

1890—AFRICA—The Economic Resources of German South-West Africa. (Bull. Imperial Inst., Apr.-June, 1915; 27 pp., illus.) General article, 3 pages of which are devoted to copper.

1891—ALASKA—Gold, Silver and Copper in Alaska in 1914. Alfred H. Brooks. (Mineral Resources of the U. S., 1914, Pt. I; 19 pp.)

1892—CALIFORNIA—The Engels Mine and Mill. Thomas T. Read. (Min. and Sci. Press, July 31, 1915; 5 pp.) 20c.

1893—CHILE—Bosquejo del Estado Actual de la Industria Minera del Cobre en el Estranjero i en Chile. Javier Grandarillas Matta. (Bol. Soc. Nac. de Mineria, May-June, 1915; 26½ pp.) Continuation of article previously indexed.

1894—CHILE—Early History of Braden Mines. (Eng. and Min. Journ., Sept. 4, 1915; 2¼ pp.) From article by William Braden in "Teniente Topics." 20c.

1895—EASTERN STATES—Gold, Silver, Copper, Lead and Zinc in the Eastern States in 1914. J. P. Dunlop. (Mineral Resources of the U. S., 1914, Pt. I; 30 pp.)

1896—ELECTROMETALLURGY—Neuerungen in der Elektrometallurgie des Kupfers. Franz Peters. (Glückauf, Aug. 14, 21 and 28, 1915; 17 pp.)

1897—FLOTATION at Washoe Reduction Works, Anaconda. E. P. Mathewson. (Min. and Sci. Press, Aug. 28, 1915; 3 pp., illus.) 20c.

1898—JAPAN—Metallurgy of Copper in Japan. Rokusaburo Kondo. (Advance copy, Internat. Eng. Congress, Sept., 1915; 17 pp., illus.)

1899—LEACHING—The Electrolysis of Copper Sulphate Liquors, Using Carbon Anodes. Lawrence Addicks. (Advance copy, A. I. M. E. and Am. Electrochem. Soc., Sept. 17, 1915; 29 pp., illus.)

1900—LEACHING PLANT at Ludwig, Nev. (Nevada-Douglas). George Westby. (Salt Lake Min. Rev., Aug. 30, 1915; 1¼ pp., illus.) 20c.

1901—METALLURGY—Progress in Copper Metallurgy. Thomas T. Read. (Advance copy, Internat. Eng. Congress, Sept., 1915; 3¾ pp.)

1902—NEVADA-DOUGLAS—Description of Mine and Mill of Nevada-Douglas Consolidated Co. (Salt Lake Min. Rev., Aug. 30, 1915; § pp., illus.) 20c.

1903—ORE HANDLING by the Magma Copper Co. (Min. and Eng. Wld., Sept. 11, 1915; 2 pp., illus.) 20c.

1904—PHYSICAL PROPERTIES of Copper. Carle R. Hayward. (Advance copy, Internat. Eng. Congress, Sept., 1915; 24 pp., illus.)

1905—REFINING—Solution Stratification as an Aid in the Purification of Electrolytes. Francis R. Pyne. (Advance copy, A. I. M. E. and Am. Electrochem. Soc., Sept. 17, 1915; 6 pp., illus.)

1906—TRAMMING AND HOISTING at Copper Queen Mine. Gerald F. G. Sherman. (Bull. A. I. M. E., Sept., 1915; 48½ pp., illus.) 40c.

1907—VENTILATION of the Copper Queen Mine. Charles A. Mitke. (Bull. A. I. M. E., Sept., 1915; 17½ pp., illus.) 40c.

GOLD AND SILVER—GEOLOGY

1908—CALIFORNIA—Pocket Deposits of the Klamath Mountains, California. Henry G. Ferguson. (Econ. Geol., Apr.-May, 1915; 21 pp., illus.) 60c.

1909—COLORADO—Ores of Gilpin County, Colorado. Edson S. Bastin. (Econ. Geol., Apr.-May, 1915; 30 pp., illus.) 60c.

1910—NEVADA—Geology and Mineral Deposits of the National Mining District, Nevada. Waldemar Lindgren. (Bull. 601, U. S. Geol. Surv., 1915; 58 pp., illus.)

1911—ORE DEPOSITS—Experiments in the Enrichment of Silver Ores. Louis G. Ravicz. (Econ. Geol., June, 1915; 22 pp.) 60c.

GOLD DREDGING AND PLACER MINING

1912—BRITISH COLUMBIA—Placer Mining in the Okanagan Valley. E. A. Haggen. (Min., Eng. and Elec. Rec., July, 1915; 1 p., illus.) 20c.

1913—GOLD RECOVERY at Placer Mines. D. F. Carver. (Eng. and Min. Journ., Sept. 18, 1915; 1⅓ pp., illus.) 20c.

1914—KLONDIKE—The Water-Supply for the Klondike Hydraulic Mines. H. H. Hall. (Min. and Sci. Press, Aug. 28, 1915; 3 pp., illus.) 20c.

1915—RUSSIA—Dredging on the Amur. K. I. Hlebnikoff. (Min. and Sci. Press, Aug. 21, 1915; ¾ p., illus.) 20c.

1916—TAILINGS—Elevating Placer Tailings with a Hayward Bucket. Hubert I. Ellis. (Eng. and Min. Journ., Aug. 21, 1915; ½ p.) 20c.

GOLD AND SILVER CYANIDING

1917—PRECIPITATION—Zinc-Dust Precipitation Tests. Nathaniel Herz. (Bull. A. I. M. E., Aug., 1915; 7 pp.) 40c.

1918—SOLUTIONS—A Convenient Alkalinity Table. P. W. Avery. (Mex. Min. Journ., June, 1915; ¼ p.) 20c.

GOLD AND SILVER—GENERAL

1919—ALASKA—Cost of Mining in Alaska. (Eng. and Min. Journ., Sept. 18, 1915; 1¼ pp.) From annual reports of Alaska-Treadwell, Alaska United and Alaska Mexican companies. 20c.

1920—EASTERN STATES—Gold, Silver, Copper, Lead and Zinc in the Eastern States in 1914. J. P. Dunlop. (Mineral Resources of the U. S., 1914, Pt. I; 30 pp.)

1921—MEXICO—Chontalpan Mine, Guerrero. (Mex. Min. Journ., Aug., 1915; 2 pp.) 20c.

1922—MILL—The Rochester Mill, Nevada. G. W. Wood. (Min. and Sci. Press, Aug. 28, 1915; 3 pp., illus.) 20c.

1923—QUEENSLAND—Mount Mascotte Gold Mine, Yungaburra. E. Cecil Saint-Smith. (Queensland Gov't Min. Journ., Aug. 15, 1915; 2¾ pp., illus.) 60c.

1924—REFINING—Treatment of Silver-Furnace Fume by the Cottrell Process. Charles H. Aldrich. (Advance copy, Am. Electrochem. Soc., Sept. 17, 1915; 8 pp.) Description of work done by Raritan Copper Works.

1925—SURFACE EQUIPMENT of the Sons of Gwalia Gold Mine, Describing Recent Additions Thereto. A. Wauchope. (Monthly Journ. West. Aust. Chamber of Mines, June 30, 1915; 6 pp., illus.)

IRON ORE DEPOSITS, MINING, ETC.

1926—CUBA—The Geology of the Iron-Ore Deposits in and near Daiquiri, Cuba. James F. Kemp. (Bull. A. I. M. E., Sept., 1915; 36 pp., illus.) 40c.

1927—ELECTRICAL PLANT of the Wakefield Iron Co. Holman I. Pearl and Joe Green. (Eng. and Min. Journ., Aug. 28, 1915; 2¾ pp., illus.) 20c.

1928—GEOLOGY—Some Problems in Iron-Ore Geology in Sweden and in America. Per Geijer. (Econ. Geol., June, 1915; 31 pp., illus.) 60c.

1929—INDIA—The Ancient Sedimentary Iron Ores of British India. C. M. Weld. (Econ. Geol., July-Aug., 1915; 18 pp., illus.) 60c.

1930—MICHIGAN—The Opening of the Wakefield Mine. W. C. Hart. (Advance copy, Lake Superior Min. Inst., Sept., 1915; 8 pp.)

1931—MINING—Rock Drifting in the Morris-Lloyd Mine, the Cleveland-Cliffs Iron Co. J. E. Hayden. (Advance copy, Lake Superior Min. Inst., Sept., 1915; 6 pp., illus.)

1932—MINING METHODS on the Gogebic Range. O. E. Olson, O. M. Schaus and Frank Blackwell. (Advance copy, Lake Superior Min. Inst., Sept., 1915; 10 pp., illus.)

1933—MINNESOTA—Manganiferous Iron Ores of the Cuyuna Range. Edward P. McCarty. (Eng. and Min. Journ., Sept. 4, 1915; 2 pp.) 20c.

1934—MINNESOTA—Some Aspects of Exploration and Drilling on the Cuyuna Range. P. W. Donovan. (Advance copy, Lake Superior Min. Inst., Sept., 1915; 16 pp., illus.)

1935—SCHOOL—The Mining School of the Cleveland-Cliffs Iron Co. C. S. Stevenson. (Advance copy, Lake Superior Min. Inst., Sept., 1915; 14 pp.)

1936—SHAFT SINKING—Sinking New "C" Shaft at the East Norrie Mine, Ironwood, Mich. B. G. Best. (Eng. and Min. Journ., Sept. 11, 1915; 1 p., illus.) 20c.

1937—SHAFT SINKING—Sinking of the Woodbury Shaft at the Newport Mine, Ironwood, Mich. J. M. Broan. (Advance copy, Lake Superior Min. Inst., Sept., 1915; 16 pp., illus.)

1938—STOCKPILE TRESTLE—New Stockpile Trestle, Colby Iron Mining Co., Bessemer, Mich. G. S. Barber. (Advance copy, Lake Superior Min. Inst., Sept., 1915; 4 pp., illus.)

1939—VIRGINIA—The Oriskany Iron Ores of Virginia. C. M. Weld. (Econ. Geol., July-Aug., 1915; 23 pp., illus.) 60c.

IRON AND STEEL METALLURGY

1940—ALLOY—The Iron-Cobalt Alloy, Fe_2Co, and Its Magnetic Properties. Trygve D. Yensen. (Gen. Elec. Rev., Sept., 1915; 6 pp., illus.) 40c.

1941—ALUMINUM IN STEEL—Note on the Determination of Aluminum Oxide and Total Aluminum in Steel. F. O. Kichline. (Journ. Ind. and Eng. Chem., Sept., 1915; ½ p.) 60c.

1942—AUSTRALIA—Smelting Works in Australia. Donald MacLaren. (Min. and Eng. Wld., Aug. 28, 1915; 2 pp., illus.) 20c.

1943—BLAST FURNACE—Chemical Principles of the Blast Furnace. J. E. Johnson, Jr. (Met. and Chem. Eng., Sept. 1, 1915; 6½ pp., illus.) 40c.

1944—CALIFORNIA—The Pacific Coast Iron Situation. The Iron Ores of California and Possibilities of Smelting. Charles Colcock Jones. (Bull. A. I. M. E., Sept., 1915; 12 pp., illus.) 40c.

1945—CARBON DETERMINATION—Platinum Boats for Carbon Determination by the Direct Combustion Method. H. F. Siever. (Met. and Chem. Eng., Sept. 1, 1915; ¾ p.) 40c.

1946—CASTINGS—Iron and Steel Castings. John Howe Hall. (Advance copy, Internat. Eng. Congress, Sept., 1915; 12 pp.)

1947—DESULPHURIZATION in Cupola Practice. (Iron Age, Aug. 26, 1915; 1¾ pp.) From "Stahl u. Eisen"; a series of German experiments to determine the extent to which sulphur may be removed by various chemicals or operating changes. 20c.

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